

R E P O R T R E S U M E S

ED 013 722

RE 000 332

A READING CURRICULUM FOR A COMPUTER-ASSISTED INSTRUCTIONAL
SYSTEM--THE STANFORD PROJECT. PROGRESS REPORT.

BY- HANSEN, DUNCAN N. AND OTHERS

STANFORD UNIV., CALIF., INST.MATH.STUDIES SOC.SCI.

REPORT NUMBER DR-5-0684-FR

FUB DATE 15 AUG 66

GRANT OEG-5-10-050

EDRS PRICE MF-\$0.75 HC-\$5.52 138P.

DESCRIPTORS- *COMPUTER ASSISTED INSTRUCTION, *READING,
*ELEMENTARY GRADES, THEORIES, WORD LISTS, REMEDIAL
INSTRUCTION, INSERVICE TEACHER EDUCATION, SYSTEMS APPROACH,
*CURRICULUM DEVELOPMENT, READING MATERIALS, INDIVIDUALIZED
CURRICULUM, STANFORD UNIVERSITY,

THE STANFORD PROJECT ON COMPUTER-ASSISTED INSTRUCTION IN
INITIAL READING, INCLUDING THE COMPUTER CONTROLLING SYSTEM AS
WELL AS CURRICULUM MATERIALS, IS DESCRIBED. THE THEORETICAL
RATIONALE FOR THE READING CURRICULUM, FOR WORD LIST LEARNING,
FOR REMEDIAL MATERIALS, AND FOR INSERVICE TRAINING IS
DISCUSSED. APPENDIXES AND REFERENCES ARE INCLUDED. (BK)

RE 000

332 SEP 7 1967

Schultz
Run 3 2 0 1 0

PROGRESS REPORT

A READING CURRICULUM FOR A COMPUTER-
ASSISTED INSTRUCTIONAL SYSTEM: THE STANFORD PROJECT

OR 5-0684
PA 24
OEG-5-10-050

ED013722

REPORT PREPARED BY
DUNCAN N. HANSEN

in association with

THEODORE RODGERS
H. A. WILSON
RUTH NORENE HARTLEY
KARL ANSELM
RICHARD LEE
JOANNE WILSON

SARAH LILLESTON
MEREDITH SMITH
THELMA WEEKS
KAREN ALEXANDER
CHARLENE BRUGGEMANN
SUSAN PERRY

August 15, 1966

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE
PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS
STATED DO NOT NECESSARILY REPRESENT OFFICIAL OFFICE OF EDUCATION
POSITION OR POLICY.

PROJECT DIRECTOR: RICHARD C. ATKINSON

INSTITUTE FOR MATHEMATICAL STUDIES IN THE SOCIAL SCIENCES
STANFORD UNIVERSITY
STANFORD, CALIFORNIA



PROGRESS REPORT

A READING CURRICULUM FOR A COMPUTER-ASSISTED INSTRUCTIONAL SYSTEM:
THE STANFORD PROJECT

Report prepared by
Duncan N. Hansen

in association with

Theodore Rodgers
H. A. Wilson
Ruth Norene Hartley
Karl Anselm
Richard Lee
Joanne Wilson
Sarah Lilleston
Meredith Smith
Thelma Weeks
Karen Alexander
Charlene Bruggemann
Susan Perry

August 15, 1966

Project Director: Richard C. Atkinson

Support for this research was provided by the Office of Education,
Grant Number OE5-10-050

INSTITUTE FOR MATHEMATICAL STUDIES IN THE SOCIAL SCIENCES

STANFORD UNIVERSITY

STANFORD, CALIFORNIA

TABLE OF CONTENTS

Introduction	1
Theoretical Rationale for the Reading Curriculum	4
Letter and Letter-String Identification.	20
Single Letter Matching	
Letter-String Matching	
Same-Different Task	
Word List Learning	22
Remedial Materials for Word List Presentation Section.	28
Matrix Construction.	34
Curriculum Materials	41
Usage	
Inquiries	
Rhymes	
Games	
Compound Words	
Polysyllabic Words	
Sentence Initiators	
Adverbial Sentence Initiators	
Stories Read to the Children	
Stories the Children Read	
Review Lessons	
The Stanford CAI System.	75
Lesson Preparation and Data Recording	
Preparation of CAI Reading Materials	
Stanford-School District Cooperative Plans and Teacher	94
In-Service Training	
Future Plans	99
Appendix	100
References	132

List Of Tables

Table 1	Vocabulary Sequencing In The Stanford Reading Materials	14-15
Table 2	Formation Of Polysyllabic Words	.52
Table 3	Audio Script And Film Frames With Hypothetical Addresses	80-84

List Of Figures

Figure 1	Word-Picture Flow Diagram	.27
Figure 2	Word-Picture Flow Diagram With Remedial Units	.32
Figure 3	System Configuration For Computer-Assisted Instruction	.76
Figure 4	Example Of Standardized Form.	.90
Figure 5	Flow Diagram Of Reading Materials Preparation For Stanford CAI Reading System	.92
Figure 6	Preparation Of Materials For Stanford's CAI System.	.93

Introduction

The purpose of this paper is to describe the Stanford Project on Computer-Assisted Instruction (CAI) in initial reading. This report will describe not only the computer system that controls the instructional process, but more importantly, the curriculum materials being presented on the CAI system. In addition, there will be a general discussion of the organization being formed within the local elementary school and the central school district in order to implement this research project.

There are several major inducements for developing a Computer-Assisted Instructional system for the presentation of initial reading materials to very young children. The primary and most obvious motivation is the potentiality of a detailed investigation of a number of reading hypotheses proposed to account for the acquisition, retention and extension of reading skills by young children. These hypotheses will be discussed in the section dealing with the rationale for the Stanford reading curricula and the section in which specific examples of the reading curricula are presented.

These reading hypotheses focus on, first of all, the nature of visual discrimination and symbolic identification processes in reading by young children. A second focus is on the process by which children learn to read their first initial vocabulary items. Here the role of pictorial associates as mediators in the acquisition of these first words is of prime concern. A third major section of the reading material investigates the developing decoding habits by which children come to read novel English words and sentential strings. The fourth and perhaps most crucial concern is understanding how children gain information during the reading process. In the curriculum, this general question concerning comprehension has been broken down into sub-questions concerning syntactic information gathered from appropriate sentential strings, the role of given semantic definitions for key words within these strings, and the

use of conventional interrogatives (why? who? what? how?) as queries to the child's understanding of the information being presented. A fifth major section of the reading curriculum investigates the role of stories as informational background and language context for the children's understanding of story themes and their reaction to these themes written in either narrative or expository form. In the later portions of the curriculum materials, there is a marked increase in the complexity and kind of syntactic and thematic material, so as to study in greater detail the child's informational processing capabilities within a reading context.

A second obvious reason for creating a Computer-Assisted Instructional system is to establish the feasibility of this mode of instruction with young children. While there is a growing literature from programmed instruction and other resources that indicates that children can profitably learn for short periods of time in an individualized mode, no long-term program has ever been undertaken covering a major portion of the elementary school curriculum. An evaluation over an extended period of time is necessary, we believe; and we plan to conduct such a study starting in September of 1966. Approximately 100 first-grade children will be involved for a daily 30 minute period throughout one school year and will receive a major portion of their reading instruction under computer control.

It is our hope that the computer-based laboratory of the type described in this report will make it possible to obtain rigorous behavioral measures on the reading curriculum and its development within an elementary school. At the same time we plan to carry out long-term learning studies under precise experimental control with the capability of collecting detailed response data. Thus the computer-based laboratory should have a direct effect on the development of a reading curriculum, as well as extending the type and scope of experimentation undertaken for theoretic reasons. This research strategy should provide the basis for developing a viable "theory of instruction," that is, a theory that will prescribe the conditions under which an instructional procedure optimizes learning. If we have a good understanding of the special

features of the reading hypotheses under investigation and have a reasonably accurate theory of learning that accounts for acquisition and retention during this instructional process, then, taken together, they will imply a set of decision rules that specify the most effective ways of sequencing the children through the reading curriculum materials.

This research strategy has created a number of problems concerning the organization of the computer hardware, the creation of new reading materials, the adaptation of conventional reading materials, computer coding of the material, and, most importantly, the data analysis of extremely detailed behavioral information on individual children. While typical reading programs are evaluated under conventional test conditions, the Stanford CAI Reading Project will provide critical information regarding the nature and points of difficulty experienced by each child at particular points in the curriculum. With the computer system it is possible to run curriculum studies under controlled experimental conditions and at the same time keep a running record of each child's performance. It has become a major undertaking of the project staff to develop new data analysis techniques that will satisfactorily analyze these learning difficulties, and to plan an array of remedial teaching alternatives that will resolve observed impediments. The study of the effectiveness of these remedial reading materials should help disclose the interaction between the ranges and types of individual aptitude differences and requirements for generically different kinds of reading materials in order to build minimally uniform competencies.

As previously mentioned, we have also undertaken an extensive cooperative program with a local elementary school district for the current year (1966-67). During the past academic year (1965-66) we have been meeting with school personnel on a weekly basis, laying plans, and discussing issues so as to best introduce this major innovation. This one year lead time has provided us with the necessary information about teacher attitudes, daily time schedules, feasible organizational patterns, and overall school district policy so that the Stanford CAI Reading Project can be a successful part of the elementary school program. These school-Stanford planned activities will be covered in a later section of this report.

Theoretical Rationale for the Reading Curriculum

This section will describe the theoretical issues underlying the various reading tasks that are being prepared for the Stanford CAI system. It is to be understood that each of the reading tasks has been formulated in order to furnish empirical evidence as to the relative viability of current proposed reading hypotheses. Potentially, each of these hypotheses may focus on a source of learning difficulty in initial reading. Ideally, each should provide some insight into the process of reading and accordingly furnish a basis for constructing a theory of reading. The overall intention of the Stanford CAI reading curriculum is to investigate as many compatible hypotheses as possible within the total reading program, and to assess their relative contributions to an overall theory of reading.

Traditionally, reading hypotheses have been classified according to the context and procedures of the accompanying instructional material. The first and major source for such classification is derived from the size of the linguistic unit being employed in reading exercises. The selected unit has resulted in labels by which the lines are drawn for the noisy but indecisive battles between the phonics and the whole-word approaches. A second classificatory scheme involves the pedagogical techniques prescribed for the teacher by reading experts. A third potential source is studies of the neurological and physiological deficiencies of readers which inhibit their ability to perform certain kinds of reading tasks. The experimental studies that have resulted from these three classificatory schema can be reviewed in Smith and Dechant (1964). After a review of these three approaches, we have concluded that a theoretical framework more oriented towards the children's general language behavior would be more viable and useful.

Recently, some newer psycho-linguistic hypotheses regarding language performance in general, have provided a classificatory schema for reading behaviors. One of these language related classificatory schema is based on the specifiable reading behaviors of the elementary school child. Reading hypotheses, consequently, can be formulated in terms of those specific behaviors that the child-learner can be led to acquire. The

particular stimulus material and task characteristics then become related to these behavioral acquisition and retention patterns. The description of a reading curriculum within this framework becomes a detailed specification of 1) the stimulus material described in terms of its psycho-linguistic structure, 2) the instructional tasks, problem types, and their accompanying presentation formats, and 3) the behavioral routines that a child learner hypothetically acquires in order to successfully perform the task. This is the general framework utilized by the project staff for formulating theories about the reading curriculum.

This psycho-linguistic classificatory approach is consistent with the current view in reading that divides the acquisitional process into two major stages (Carroll, 1964). The first stage has as its main objective the growing understanding by the child that the orthography presented on the page corresponds in a translatable way to speech behaviors which he has mastered prior to any reading instruction. For us, the learning process in this initial stage of reading is conceptualized as a rehearsal process, associational in nature, whereby the appropriate phonologically defined pronunciation units are related with given orthographic patterns. Thus the initial stage is one of learning a set of decoding routines for translating the printed symbols into consistent oral speech patterns.

The second stage has as its major objective the child's comprehension of a written passage. This comprehension process is defined in terms of the dependent measures, such as answers to reading questions, that are hypothesized to detect the information processes and memory factors relevant to the reading act. One should notice that the demarcation between these two stages in reading is also consistent with similar demarcations in the levels of theoretical structure in current linguistic theory (Postal, 1964).

A psycho-linguistic theory, whether intended to describe speech or more general language behaviors (including reading), requires some form of a phonological component. This phonological component, must specify how the acoustic signals, the noises of speech, are translated into phonetic coding units, and how such units are further analyzed by the

listener for syntactic and semantic information. The process by which the acoustic signals are converted into some type of phonetic code may be described in terms of types of phonotactically possible sound sequences or speech patterns found in the language (Halle and Stevens, 1960). For example, the predominant phonetic sound sequences in English include the patterns, consonant-vowel-consonant (CVC) and consonant-vowel (CV). Most frequently, the elements filling consonant (C) positions are "stops" or sounds like those in cat or top. In any language, a limited subset of all possible sound patterns actually occurs.

One can further note that some occurrent sequences display much greater frequency of token (item) and type (pattern) than others. One can demonstrate a gradation of sound patterns in English that specifies a scale from most to least favored sound sequences. This scaling can be explained from either a rehearsal or a speech frequency point of view. For example, a phonotactical rule or a simple practice explanation could be advanced to account for tsad being more difficult for a speaker of English to pronounce than dats. This suggests that one might select the most favored sound patterns in forming the initial vocabulary in order to facilitate the initial decoding stage of reading. We have formalized this principle by means of a constructed scale of syllabic types--the scale specifying, as we have suggested, the range of occurrent English syllables from most to least favored. This scaling has resulted in a schema called Vocalic Center Groups that is used to determine sequencing of the major vocabulary blocks in the Stanford Reading Curriculum. Vocalic Center Groups (VCG) will be discussed in greater detail in a later part of this section.

In considering the role of this phonological component within a reading context, one may hypothesize that the child learner acquires a set of decoding rules that translate the permissible English printed (orthographic) patterns into appropriate English phonotactic (sound) patterns. It is to be stressed that the child-learner has already acquired these English phonotactic patterns in speech prior to any reading instruction. The primary question at this stage deals with the choice of units within phonological and orthographic sequences. Depending on

the size of these units one finds varying types and degrees of regularity with which the orthographic symbols map into the speech units. Some letters like m in English are always represented phonemically in essentially the same way. Other letters take on a variety of phonemic representations like c in cat, cinder, choir, or church. One can order both letters and words according to the degree to which they are consistently represented by the same sound phoneme or phoneme sequence. The degree of letter to sound (graphic to phonic) isomorphism in the initial vocabulary is hypothesized to determine the degree of success a child has in mastering the first stage of reading. Thus the criterion of "regularity" has become a crucial question in the construction of initial reading materials.

Regularity Relationships. We shall now analyze in greater depth the various formulations of the "regularity" hypothesis in reading materials. First, we shall present a sample grapheme to phoneme (letter to sound) formulation that we found untenable in light of existing evidence. Next we shall cover a letter sequence to sound sequence formulation of regularity which has three main sub-formulations: a) phonotactics, b) grapho-tactics, and c) morpho-tactics. Regularity rules derived primarily from phonotactic considerations and, secondarily from grapho-tactics, form the basis for the Vocalic Center Group construct and, in turn, the Stanford vocabulary sequence. However, we have been unable to utilize the morpho-tactic formulations to any considerable degree. We then will consider the interrelations of these regularity principles with the observed frequencies of tokens and types of word patterns. And finally, we shall precisely state the propositions based on the Vocalic Center Groups by which the Stanford vocabulary is sequenced.

A regularity hypothesis can be formulated as a set of rules designed to represent varying degrees of correspondence between the units of orthography and speech pronunciation. First, regularity can be specified at a grapheme-phoneme equivalence level, whereby each discrete letter is representable by a discrete sound. This formulation of the criterion of regularity is untenable on several grounds. The isomorphism between single letter and single sound can be shown to be illusory in the

relationship, for example, between the set b, d, g, p, t, k, and their sound "equivalents". One cannot "sound" these units without appending a vowel. Further, letter-sound isomorphism does not generally hold due to the orthographically unrepresented variations of speech sounds in context (allophony) (e.g., the five perceptually different sounds represented by the one letter t in the words tap, trap, latter, mountain, and pat). Variations in pronunciation caused by geographical, social, and space-time factors further confound isomorphism at the letter-sound level. Thus, the characteristics of writing systems and natural languages suggest that one must dismiss the rubric advanced in certain reading manuals that a given letter has a given sound.

A second view of regularity stresses the isomorphic relationships between a letter sequence and a sound sequence. The appropriate sequential units are determined on the basis of sound patterns (phonotactics), letter patterns (grapho-tactics), or word patterns (morpho-tactics).

Recent so-called linguistic materials have tended to concentrate on the first of these, phonotactic isomorphism, usually at the level of the simple CVC syllable or monosyllabic word (e.g., "Dan can fan Nan.") We concur that a reading approach stressing the regular relationship between letter strings and sound sequences (syllables and words) will provide the child with a series of hints or approximation rules that help him over one of the major hurdles in reading--that of simply generating some appropriate sound. Consequently one will find phonotactically structured materials, or those emphasizing letter sequence to sound sequence regularities, in the remedial branches of our reading decoding sections called matrix building. Within the material the child is presented with activities that encourage manipulative facility with simple vowel-consonant patterns such as at, an, etc. These simple patterns are used as a basis for extended practice over more complex syllabic types (e.g., at → rat → prat → sprat). As noted previously, the major scheme for displaying the regular relationship of letter sequences to sound sequences is in terms of the scaling of Vocalic Center Groups.

Grapho-tactic sequences, the second form of regularity relationships, are usually defined as those sets of letters which, considered as a unit,

can be said to stand in some isomorphic relationship to a sound (or sound sequence). The letter to sound relationship is not inferrable from any regular relationship existing between the individual component elements (letter-sound) of the graphic and sound units. Thus, the initial graphic sequence sh is regularly related to the phoneme /ʃ/ (e.g., ship > /ʃip/). This fact is independent of any other regular relationships between initial s and /s/ as in sip and initial h and /h/ as in hip. One cannot infer the pronunciation of ship by relying on prior knowledge concerning the pronunciation of sip and hip. (This assumes, of course, that in some sense one may infer the pronunciation of stop with certain prior knowledge concerning the pronunciation of sop and top. The point is that the sequence st as pronounced in stop is constructed from the individual pronunciations of s and t in a way that the sequence sh as pronounced in ship is not constructed from individual pronunciations of s and h.) Other grapho-tactic units include initial wh, qu, ph (when, quick, phone); medial and final doubled consonants (manner, ladder, off, mess); final consonant groups as -dge, -ck, -mb, -ng, -nk (bridge, back, thumb, ring, sink), and so forth.

Grapho-tactic units are introduced as unanalyzable components in the Stanford materials (sh + op → shop not s + hop → shop, and not sop + hop ⇒ shop). The grapho-tactic patterns are sequenced on the basis of the regularity of correspondence between letter patterns and sound patterns. The grapho-tactic units sh and ph are considered to be more regular than ch. Thus, initial sh → /ʃ/ (ship) and ph → /f/ (phone) are introduced before initial ch → /tʃ/ or /ʃ/ or /k/ or /kw/ (chip, chef, character, choir).

Morpho-tactic sequences, the third form of regularity relationships, (the usage is our own) have been less thoroughly analyzed than have phono- and grapho-tactic sequences. An extreme morpho-tactic position would be the one held by whole-word recognition or look-say reading proponents. The claim here is that the minimal set in which an isomorphism between symbol sequence and sound sequence can be said to occur is a set consisting of a word and that word's given pronunciation. From this point of view any attempt to teach reading on the basis of lower level

correspondences (letter to sound or letter sequence to syllable) would be inappropriate and ineffectual. This whole-word position thus seems extreme to us, and is less commonly held by any current reading investigator.

A less extreme approach to morphotactic regularity may be suggested by the following case. From a phoneme-grapheme or letter sequence-syllable point of view, the pronunciation of initial th is unpredictable, that is, irregular. Thus no correspondence rules exist for predicting the initial phonemes of thy versus thigh; then versus thin. However, given certain information about the morpheme classes to which these items belong, the mapping of th is predictable and, hence, regular. (The rule is, roughly: initial th in mono-morphemic adverbs and pronouns $\rightarrow / \text{ð} /$ (they, then, that, thy); elsewhere initial th $\rightarrow / \theta /$ (thigh, thin, think, through)). A still less extreme position is that taken by Weir in her statement that "the recognition of morpheme boundaries is crucial for obtaining much of the regularity that exists in the grapheme-phoneme relationship," (Weir, 1964). The pronunciation of medial -st- as in moisten and tungsten is predictable, regular, only when we know that there exists a morpheme juncture after st in moisten (moist + en) but not after st in tungsten, that is, where -st- immediately precedes a morpheme boundary -st- $\rightarrow / s /$ (/mɔysən/) and where no morpheme boundary follows -st- $\rightarrow / st /$ (tənstən/).

The rules defining morpho-tactic regularity are so complex and the number of examples per rule so limited that we have been unable to find, for our purposes, any viable meld of morpho-tactic and pedagogical principles. Thus the phonotactic and grapho-tactic views of letter to sound regularity have a major role in the sequencing of the vocabulary of the Stanford Reading Curriculum.

A last formulation of regularity concerns the frequency of a given letter to sound pattern, and the decision procedure utilized to determine the dominant letter to sound correspondence rule for competing patterns. If there is only one sound for a given letter string, there are no alternatives and no real problem to be faced. But, in the typical case, there may be a variety of phonemic possibilities for a given letter sequence. For example, one might select the series room, loom, moon,

soon, noon as representing the "regular" pattern for oo because of the high token frequency of these particular words. Having made a decision here, two questions still remain. How many examples are necessary in order to establish dominance of a particular letter to sound correspondence? What presentation of these examples will lead to acquisition of the concept of regularity and related decoding behaviors?

In the case of the Stanford CAI reading materials, the initial vocabulary is carefully selected so as to maximize both inter-lesson regularity and intra-lesson consistency. At systematic points, "irregularities" of the several types described above are introduced in order to assess their inhibiting effects on the formation and permanence of the correspondence rules.

The Stanford CAI reading curriculum is testing these various psycholinguistic propositions about regularity and specifically the contrasting dominant-subordinant patterns in order to find which are the easiest to acquire. This will hopefully lead to an optimal sequence of the overall set of reading materials. The experimental design consists of separating different instances of correspondence rules into self-contained lessons. Each of these lessons will be compared to the detailed progress in other contrasted lessons. Thus, as one carefully looks at the Stanford material, one notices many alternative formulations of the concept of regularity being manifested at given points in the curriculum sequence. The whole concept of vocabulary patterning will shortly be reviewed when we talk about the overall sequencing of material in the Stanford CAI reading program. ✓

To summarize our views on the phonological regularity aspect of initial reading, we have postulated a syllable-like unit called the "Vocalic Center Group" (VCG) to structure the behavioral routines taught in initial oral reading. In initial reading, it is these minimal pronunciation units (VCG) that are rehearsed, we hypothesize, by the reader so as to build the associations between the orthographic patterns found on the printed page and the pronunciations which we call oral reading. It is to be noted that the VCG is structured in the sense that it is the minimal sequence within which all rules of English

phonotactics can be stated. These phonotactic rules account for the process whereby phonemes are positionally modified so as to form phonotactically permissible and psychologically interpretable pronunciation sequences. We hypothesize that the more complex the set of phonotactic rules over a particular VCG, the more difficult the rehearsal process, and, consequently, the more difficult the "reading" will be. Accordingly we have an overall hypothesis for determining learning difficulty for certain kinds of pronunciation units and their associated orthographic patterns. These psycho-linguistic propositions are manifested in the Stanford reading materials in the ordering of our word lists and matrix learning materials.

A more extensive review of the theory and experimental evidence underlying the Vocalic Center Group propositions may be found in "An Exploration of Psycho-linguistic Units in Initial Readers" by Hansen and Rodgers (1965). The salient propositions are as follows:

- 1) Consonant clusters are more difficult than single consonant elements; therefore, all consonant elements are initially introduced in minimal syllabic units (e.g., vc or cvc units such as at or cat).
- 2) Prevocalic consonant clusters are easier to rehearse than post-vocalic consonant clusters; therefore, consonant clusters and digraphs are introduced in prevocalic positions (e.g., stop before pots; shut before push).
- 3) Simple check vowels are easier than letter name vowels or diphthongs; therefore, the check vowels are the first vowels introduced in the initial vocabulary (e.g., mat before mate; bat before bait).
- 4) Monosyllabic units are easier to rehearse than polysyllabic units, therefore; monosyllabic components of all polysyllabic words are introduced as individual elements, whether as words or nonsense syllables (e.g., but before butter; strat before strategy).

These four propositions form the general organizational plan by which vocabulary words are classified and sequenced in the reading lessons.

The overall sequence of new words may be reviewed in Table 1. The table is keyed to the simple check vowels (lower case letters), letter-name vowels (upper case letters), consonants, and consonant clusters. It is to be noted that the term "level" has no great organizational significance, but is only a convenient manner of segmenting the sequence at certain points. Each cell of the consonant-vocalic structure is keyed according to the vowels being utilized. All the potential words that result from the commuting of consonants about the vowels are presented, consonants being referred to by C and vowels being specified. The last column in Table 1 indicates the points at which both consonant and vowel letters are introduced in the lessons and their sequence.

The sequencing of monosyllabic words within the Stanford CAI reading lessons is highly similar to other existing forms of linguistic-based reading materials. The principal difference is that the precise branch points and sequence steps for the introduction of words are quite explicit, in order to evaluate the proposed psycho-linguistic propositions about reading. A complete list of the monosyllabic words introduced in the lesson material may be found in Appendix A.

As one would anticipate in the preparation of "readable" sentence and story materials, we have had to introduce words with irregular patterns and, consequently, irregular letter to sound correspondences. The first of these irregular patterns is represented by the contractions. We chose the contractions (e.g., it's, I'm, he's, she's) for the following three reasons:

- 1) they have high frequency in children's speech;
- 2) they provide sentence elements to which any noun phrase can be easily and naturally attached; and
- 3) they are graphemically marked with an apostrophe.

The use of contractions even in the early lessons permits the use of phrase and sentence material which is very natural but which still retains the vocabulary patterning. The total list of contractions can be found in Appendix B.

A second source of irregular patterns is the syntactic or function words we found necessary for sentence writing; these can be viewed in

TABLE 1

LESSON SEQUENCE

LEVELS	vc	cvc	ccvc	cVc/ ccVc/ cccVc/	cV ccV	cVcc ccVcc	cVVC ccVVC	cVV ccVV cccVV	cccvc cvccc
I	ac	cac							
II	ic	cic	ccac						
III	ec	cec	ccic	cAc/ ccAc/	cA*				
III'		av ir ar ax ir ix ix	ir ax ar ix av	Ar/ Al/ Ar/ Ar/		ack ell ick ill eck ass all ess			
IV	oc	coc	ccoc	cic/ ccic/	ci cY ce ccY ccE	cacc			
IV'				Ir/ Iv/ Il/ Iv/ 1ve		oss olt and pil ark arm ock art set arn	al oo ight	ay	
V	uc	cuc	ccoc	cEc/ ccOc/ ccOc/ ccOc/	co ccO	place cccc cccc ccicc cccc			ccc c c c ccc
V'		ur ox or ux er er	ur ux or ox er	Ur/ Ov/ Ol/ Or/ Uv/ Ul/ Ur/ Or/	ang fild eng old ing alk ung ost	ee-ea ou-ov oa-ov nu-av oi e'a	ov ee ea oy		
bve bme ind ort									
VI			ccuc		cu*	cucc cocc ccucc ccccc	le el		cccuc cycce

TABLE 1 (continued)

LEVELS	Syntax and Function Words	Syntactic Endings	Compound and Polysyllabic Words	Letter Introduction
I	Contractions a an the			a, b, c, d, f, g, h, m, n, p, r, s, t
II	Prepositions or, in, at, to, of and, or	N - plurals V - 3rd person singular V - ing		l, w, i
III	Contractions as has was were	er, est (compara- tive, superlative) er-one who does ed-past tense verbs	Introduce Com- pound Words	e
III'	Introduce Function Words		Introduce Polysyllabic Words	final position: k, v, x
IV	Adverbials Contractions Question Words: for, from			
IV'				initial position j, k, v
VI				initial position y, z, qu

in Table 1 in the column of syntax and function words. Examples of these function words are the articles the, a, and an introduced in Level I. These words are taught within the context of sentences and are not associated with the decoding exercises found in the lessons. Similarly we have introduced a large number of prepositions and conjunctions in Level II. These additions of irregular words permit a certain complexity in the structure of sentences being presented. We also introduce a number of inflectional endings such as those indicating plurality and verb tense and person. These represent irregularities, but are necessary in order to present a variety of grammatically correct phrases and sentences. A list of the function words can be found in Appendix C.

In Levels III', IV', and V' we have systematically introduced irregular letter to sound correspondences which allow us to evaluate more rigorously the hypotheses about regularity. The irregularities found in Levels III', IV', and V' represent, in our opinion, the predominant irregular patterns of English; their use permits us to introduce the essential vocabulary found in the first 5,000 words of any reading series. The precise patterns can be viewed by scanning the rows of Table 1 marked III', IV', and V'. A complete list of all regular and irregular words can be found in Appendix A.

Compound words are introduced in Level III and are initially composed of two known monosyllables (e.g., bat and man are taught prior to the presentation of batman). We then introduce compound words in which only the initial word has been previously taught. Therefore our approach to compound words is primarily a learning-transfer process in that at least one known morpheme or syllable forms a part of each new word. For example, we introduce the sequence redwood, redakin, and redcap after the word red has been taught to the children. These words then become available for use in syntactic and story materials. The sequence for the compound words can be seen in Appendix D.

Polysyllabic words are introduced in Level III'. The polysyllabic word sequence derives from assumptions regarding the roles of stressed and unstressed syllabic pronunciations on word perception and cognition. To evaluate the influence of syllabic stress, the initial polysyllabic

words are formed according to the following six rules:

- 1) The words are at first di-syllabic;
- 2) The first syllable of the word is stressed;
- 3) The vowel of the final syllable is represented as phonetic /ə/;
- 4) The first syllable is regular in that it has been learned in the word list and matrix exercises;
- 5) The word is monomorphemic (e.g., one meaningful word); and
- 6) The words are found in the Large-Thorndike Word List (1944).

These criteria are followed in the lessons in Level III' and IV; however in Level IV', the first constraint requiring di-syllabic words is relaxed in that tri-syllabic words are introduced. A complete list of the polysyllabic words used is to be found in Appendix E.

This approach to polysyllabic words was chosen as we feel that the stressed syllable of a polysyllabic word is a highly significant factor in both rehearsal and memory processing. The schwa vowel, 'ə', in the final syllable is universally neutral and, consequently, easy to acquire from a reading point of view. We maximize the possibility of transfer learning by 1) using only polysyllabic words whose first syllable is a word or nonsense syllable that has been previously taught in the word list and decoding exercises, and 2) restricting the polysyllabic words to monomorphemes to limit semantic confusion.

Syntactic and Semantic Aspects. The sequencing hypotheses we have formulated concerning syllables (Vocalic Center Groups) and words are most explicit and will therefore be quite easy to evaluate. In addition to these sequencing hypotheses, we have investigated a number of syntactic and semantic questions concerning general reading comprehension. These investigations have not resulted in a general framework but rather a series of syntactically and semantically related questions. Therefore our approach to the larger linguistic units such as phrases and sentences and to reading comprehension, generally, is eclectic and necessarily more general and abstract in nature than our approach at the word level.

When larger linguistic structures such as phrases or even sentences are considered, the word list pronunciation behaviors of the initial reader must be supplemented by an intonational coding system that accounts

for the pitch and stress contours of natural utterances. These intonational codes as they relate to reading can best be reviewed in the work of Lefevre (1964) or more extensively in Pike (1945). Opportunities to relate the intonational code of speech to reading is provided in materials called "sentence initiators". These materials attempt to fuse the natural intonational habits of speech with oral reading behaviors, as well as allow for productive practice on the use of learned vocabulary in contextual settings.

Syntactic considerations in a psycho-linguistically oriented reading curriculum include content, cuing, and constraint characteristics of grammatical form classes, of word order, function words, affixes, and punctuation. Since there is a high degree of mutual reinforcement and redundancy among these signals, it is possible in a sentence context to jointly build from one signal type to another. For example, the concept of singularity in sentence subject marked by a preceding article an will be reinforced by the suffixal -s in a simple present tense verb in the sentence predicate. We have also attempted to investigate the cuing role of phrase markers (in the generative-transformational sense) in sentence structures. This we have pursued in both the "sentence initiators" and the "adverbial sentences"; these materials will later be discussed in greater detail.

The problem of semantic analysis or informational processing in initial reading is one of defining how the child-learner, utilizing a finite number of meanings of an acquired vocabulary and a set of rules governing grammatical construction, can process and store a semantic representation of materials read in his memory mechanism. Semantic analysis can be viewed as the tactics by which specified rules of the grammar operate with word meanings so that the totality of words in a sentence can be characterized in some informational representation. This can be done by postulating the existence of abstract memory elements and semantic key words, these representing the conceptual contacts between the immediate reading material and the reader's present cognitive state. For example, we can postulate a mechanism that relates a key word concept marker like maleness with lexical items such as man, boy,

father, uncle, etc. In turn, these key word labels and the subsumed lists of words can be contrasted with the antonymic concept marker femaleness with its list of subsumed words such as girl, mother, aunt, etc. The semantic processing tactics in reading, accordingly, must allow for a set of projection rules that will combine the meanings of the word and the syntactical phrase structure markers of the sequence of the words in a sentence so as to map a reading acquired informational structure onto the existing conceptual structure of the reader.

The output of the semantic component in our informational terms can be characterized as a series of ordered key words that are related in a list processing fashion to the substance of a reading passage. A crucial question is how this assumed end product of semantic tactics relates to the type or style of inquiries or questions that test the behaviors of reading comprehension. We evaluate comprehension at the sentence level in the section labelled "Inquiry." This consists of asking the conventional interrogative, who, what and when in regard to the subject-predicate relationships. We also utilize the same inquiry approach to the short stories the children both hear and read in the lessons. Students are also encouraged to make subjective evaluations on the quality, appropriateness, and entertainment value of the story materials. We hope thus to tap aspects of emotive and associative semantic processing as well as merely denotive processing, to which our discussion has been limited to this point.

We will now turn to explicit examples of the various parts of the Stanford CAI reading curricula and more specific rationale as to their purpose and nature. Within any typical lesson, the material is sequenced from the simpler letter discrimination materials in the initial sections of the lesson through the vocabulary section and ultimately on to the more complex and interesting materials found in the listening story activities at the end of the lesson. Any given lesson is composed of selected units from the entire reading curriculum. This selection process is contingent on the learner's level of progress. In the earlier lessons there is an emphasis on simpler discrimination and identification tasks, while the later lessons focus almost completely on vocabulary, syntax,

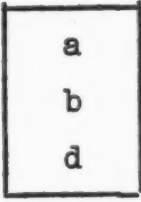
and story materials. The various appendices at the end of this document indicate the precise sequencing of words, phrases, sentences, games, compound and polysyllabic words, and stories, whether read to the children or by the children. A detailed description of the IBM 1500 CAI system on which the reading materials are implemented can be found in a later section. We suggest that those readers who are not familiar with CAI systems turn to this section before proceeding to the description of the actual curriculum examples which are used by the system.

Letter and Letter-String Identification

The curriculum materials on letter and letter-string identification are based on the work of Gibson (1962) suggesting that children must learn to differentiate and perceptually code English letters as a prerequisite to the reading decoding task that relates letter patterns to sound patterns. On the basis of her developmental studies, Gibson concludes that certain distinctive features that allow for unique identification of given letters are critical dimensions in learning to avoid confusion between words in reading. Some of these same features, such as straightness or curvedness, are used by children prior to their entrance into school to identify objects they see about them. Such distinctive features are hypothesized to be transferable to the initial reading task. However, other distinctive features such as rotation, reversal, and intersection have to be acquired in the specific context of reading. Thus some work in discriminating and identifying English orthographic symbols is prerequisite to the first stage of reading instruction.

A deeper rationale for the relation of this type of coding activity to reading is as follows: the child must perceive and encode the distinctive features of a given letter-string representing a word and retain it in some type of immediate memory buffer while he proceeds through a pronunciation-rehearsal routine. If the child does not possess a set of orthographic encoding techniques that allow for absolute identification of letter-strings, there is a possibility that confusions between two words may take place during the rehearsal process. Thus, the emphasis in the early reading materials is on correct identification of specific letters in different orthographic environments.

Single Letter Matching. A model letter is presented on the projector and two or three letters are presented on the cathode-ray tube (CRT). The wrong alternatives are designed to include letters considered to be easily confused due to their similar orthographic features. The student is requested to choose the letter on the scope that matches the model presented on the projector (see the later section of this report on the CAI system for a more detailed description of the terminal equipment). Letter names are used in the audio directions, but there is no attempt to formally teach letter names. The emphasis is on discrimination and recognition of individual letters and letter strings. All new letters are introduced within the following format:

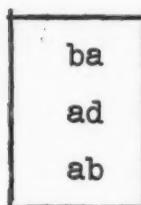
Projector	Scope	Audio
		(Au1) Look at a in the picture box. Touch a on the scope.
Problem Sequence: PR, DS, DP, AU, RR, CA (Au2), WA (Au3)		CA: Yes, that is a.
		(Au2) ↓CA
		WA: No, this is a.
		(Au3) Touch it.
(The problem sequence is written in the two-letter codes and is explained in the section describing the CAI system.)		

Letter-String Matching. A model string of two or more letters is presented on the projector and a choice of two or three strings is presented on the CRT. The student is requested to choose the alternative that matches the model string on the projector. The alternative letter-strings include reversals, one letter differences, two letter differences, and easily confused letters. The emphasis is on the serial order constraint for word identification.

Projector

Scope

Audio



(Au1)

Look at the letter-string in the picture box. Touch the same string of letters on the scope.

CA:

Yes, do the next one.

(Au2)

WA:

No, that is a different

(Au3)

letter-string. Try again.

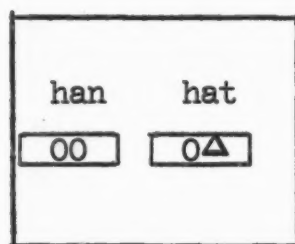
Problem Sequence: PR, DS, DP, Au1, RR, CA (Au2), WA (Au3)

Same-Different Task. Two letter-strings are presented on the scope.

The student is requested to touch one of two boxes that designates whether the letter-strings are the same or different. The letter-strings are designed to include reversals, one letter differences, two letter differences, and easily confused letters. This task provides additional opportunities to acquire coding cues and the serial order concept of letter sequences within words.

Scope

Audio



(Au1)

Look at the two letter-strings. If they are the same, touch the same box ☐ 00. If they are different, touch the difference box ☐ 0Δ. Are they the same or different?

CA:

Yes, they are different.

(Au2)

WA:

No, they are different.

(Au3)

Touch this ☐ ^{↓CA}.

Problem Sequence: PR, DS, Au 1, RR, CA (Au2), WA (Au3);

Word List Learning

Word recognition skills or word pronunciation behaviors have been the core of the "look-say" reading approaches. Closely alligned with this "whole-word" approach has been the accompanying use of referential or pictorial materials. These beginning reading texts present stories

by means of pictures and accompanying word items representing highly potent verbal associations to the pictures. Underlying this type of presentation are the two psychological considerations of meaningfulness and mediation. It is hypothesized that the meaningfulness of a word, whether it is operationally defined in terms of frequency of usage (heard or spoken) in speech or the number of free associations elicited, influences the learning process by increasing the availability and associational network of that word. For example, a picture of a dog increases the meaningfulness of the word dog by increasing the probability of the reader's saying dog and by reminding the reader how dogs act and look, that is, barking, running, biting; hair, tail, long ears, etc.

In regard to the role of mediation in the learning process, it is proposed that the pictorial representation of a word acts as an intermediate link or cognitive bridge between the orthographic word and its pronunciation. Thus, the orthography brings to mind the associated picture which, in turn, increases the probability of a correct pronunciation of the given word.

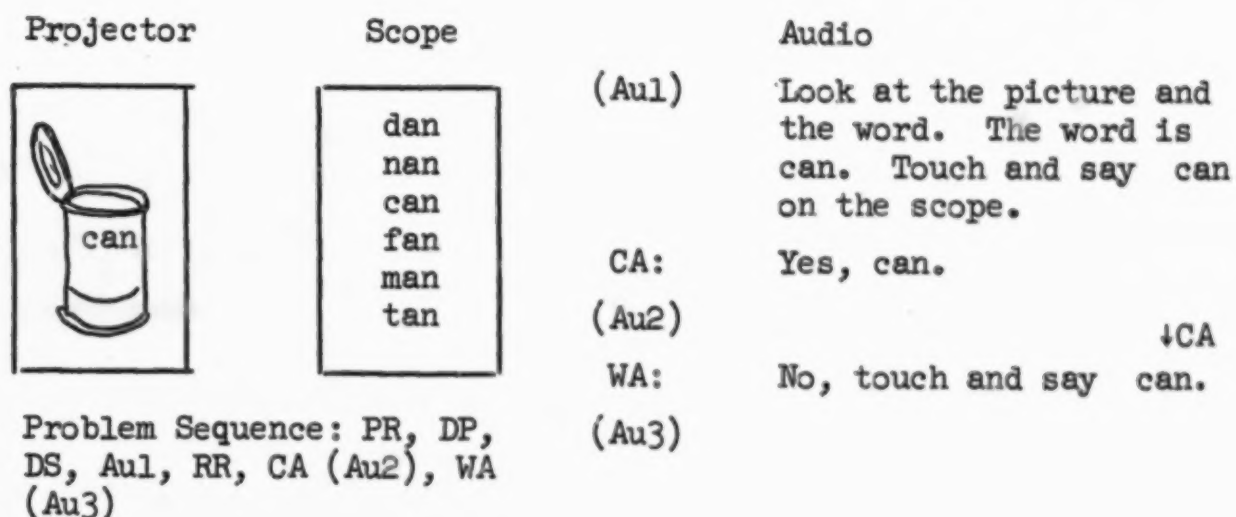
The use of pictorial materials in beginning reading has been criticized by some investigators. They claim that pictorial material detracts from or interferes with the reading decoding behavior which is the really crucial concern. The investigation of MacKinnon (1957) indicates that there is great variability as to what word a child will say when he looks at a given pictorial representation. If, in fact, pictorial material plays a significant mediational role in word decoding and pronunciation behaviors, then those words which have picturable referents should be easier to acquire and remember than those that do not. The large number of words from the form classes of modifiers and function words provide a direct comparison group for evaluating this question. Thus, in this section of the curriculum we have systematically controlled the use of pictorial materials so as to assess their role as successful reading mediators. As suggested, we will also investigate word form class as a variable in vocabulary acquisition.

All of the material in this section has been framed in a paired-associate paradigm. This has been done primarily to aid our analysis

of the learning data. Many of the existing quantitative learning models for paired-associate learning (Atkinson, Bower, and Crothers, 1965) can be utilized to describe the acquisition process and to assess the effects of learning and forgetting. We are also interested in the question of optimizing reading behaviors, that is, at certain points we wish to optimize correct initial pronunciation of new words. Although we are only using a limited number of optimization schemes within this first version of the curriculum it will be quite easy to vary these optimization schemes in the future so as to fully explore their impact on the initial reading performance.

Stage A: Word-Picture Presentation (Cues: Picture, Orthography, Audio).

The printed word and its pictured referent are presented on the projector screen. The word and other words from the lesson are random-ordered and then presented on the scope. The word is pronounced to the student. The student is requested to "touch and say" the word on the scope (i.e., find and touch the pronounced word while rehearsing it). If the student makes an incorrect response, the word is repeated at the end of the list under an optimization routine that insures one correct initial response for each word.



Stage B. (Cues: Picture and Audio). The picture without the accompanying orthography is presented on the projector screen and the words in re-randomized order are presented on the scope. The student is requested to touch and say the word on the scope which has been pronounced. If the student makes an incorrect response, he branches back to Stage A for additional practice on the word with both picture and orthography. He then repeats the task in Stage B. The list is optimized in that one correct initial response must be made for each word.

Projector



Scope

dan
nan
can
fan

Audio

(Au1) Touch and say can.
CA: Right, can.
(Au2)
WA: No, touch and say
(Au3) $\downarrow$ CA
can.

Problem Sequence: PR, DP2,
DS, Au1, PR, CA (Au2), BR,
DP2, WA (Au3).

Stage C. (Cues: Audio Only). The list of words is presented only on the scope. The student is requested to touch and say the presented word. Since this is a training task for a later criterion test, no branching procedures are employed. One correct response for each word is again optimized.

Scope

nan
tan
dan
can

Audio

(Au1) Touch and say can.
CA: Yes, can.
(Au2)
WA: No, touch and say can. $\downarrow$ CA
(Au3)

Problem Sequence: PR, DS1,
Au, RR1, CA (Au2), WA, BR,
DP, Au3.

Stage D (Cues: Picture Only). The pictures from Stage A are presented on the projector one at a time in random order. Three words are displayed on the scope in connection with each picture. The student is requested to touch and say the word that is represented by the picture.

Projector	Scope		Audio
	fan nan can	(Au1)	Touch and say the word that goes with the picture.
		CA:	Good, can.
		(Au2)	
		WA:	No, the word that goes with the picture is
			↓CA can.
		(Au3)	Touch and say can.

Problem Sequence: PR, DP2, DS, Au1, RR, CA (Au2), WA (Au3).

Stage E: Criterion Test for Word List (Cues: Audio Only). This task is similar to Stage C except that no feedback or correction is given on the first presentation of the list. If the student meets criterion (i.e., no errors) on the first cycle, he leaves the word-list presentation block. If he does not meet criterion, he returns to the task described in Stage B, branches past Stage C, and is presented with those items in Stage D which he missed in Stage E. He then makes a second cycle through Stage E with correction and optimization of one initial correct response in each item.

The problem route for these five stages is represented by the following flow diagram in Figure 1. Correct response routes are indicated by solid lines and remedial branches by dotted lines.

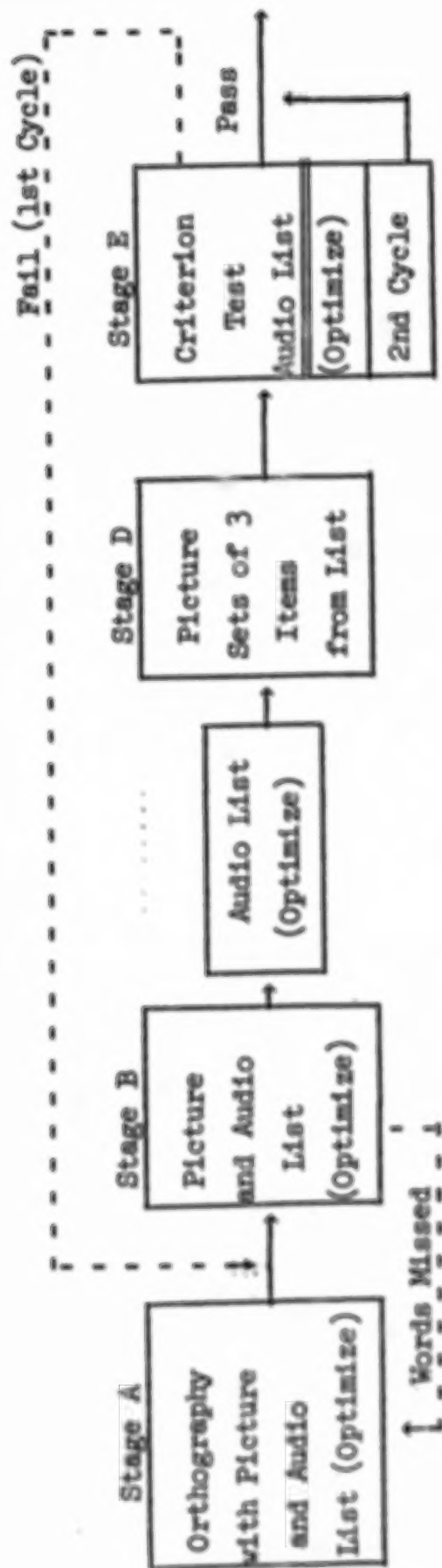


Figure 1
Word-Picture Flow Diagram

Remedial Materials for Word List Presentation Sections

Experimental studies conducted with five and six year old children indicated to us that the performance of a small percentage of the students was lower than anticipated on the word list materials. It was difficult at that time, and is even now, to specify all of the problems of these slow learning students since the learning difficulties were varied and complex. However, the learning problems can be grouped into four categories:

- 1) A failure of attention given to the stimulus discrimination of the initial or the final units of words both as letters and as sound patterns;
- 2) A need for practice with fewer words. The memory processing capacity of some student seemed to be over-taxed;
- 3) A need for extensive practice on given words that troubled a particular child; and
- 4) A need for a richer semantic context within which to relate the new words being learned.

Therefore four sets of remedial materials to supplement the word presentation section were developed to give additional practice to those students experiencing the above problems.

Letter-Word Saliency. The letter-word saliency materials are intended to focus the attention of the student on the initial and final letters of each word. Attention to these letter units is directed visually rather than aurally. The full list of words is presented on the scope. One of the words is presented on the projector with the initial letter printed in a different color and accompanied by a picture that is either directly associated with the meaning of the word or with the visual form of the letter itself. For example, the word hag might appear on the projector with the letter h printed in red, and surrounded by the facial features of a witch. The initial letter h, however, is the only letter of the word which is imbedded in the witch's face. The student is then directed by the following audio message to look at the picture box: "The word in the picture box is hag. Look at the initial

letter of hag." The request is then made to "Touch and say hag on the scope." In the second presentation of the word hag, the final unit, ag, is printed in red and is incorporated in the picture of a hag. The student is again told, "The word hag is in the picture box. Look at the final unit of hag. Touch and say hag on the scope." The third presentation of the word hag incorporates both the initial and final units in the picture of a witch or a hag. The student is again directed to look at the picture box and told that the word is hag. He is then again requested to "Touch and say 'ag on the scope."

The three presentations of any given word are not consecutive; instead, the entire list of words is presented with attention drawn to the initial units of each word, followed by a second presentation of the entire list with the attention drawn to the final units, and then, finally, the list is repeated once more with the attention drawn to the entire word.

Alliteration and Rhyming. The alliteration and rhyme materials are intended to focus the student's attention on the initial and final units of the word by an aural rather than a visual mode of instruction. This is accomplished by the direct use of alliteration and rhymes. For example, the word nag appears on the scope. The audio message is, "This word is nag. Here are some more words like nag. Each one begins with the same sound. Read then with me: Nagpur, nagging, nagged, naggingly. Touch and say the word nag." As this alliterative pattern is aurally presented, the target word appears on the scope and remains until the student has touched the word nag.

The same repetitive procedure is used in the rhyming patterns. For example (again using the word nag), nag appears on the scope and the student receives the following audio message, "This word is nag. Here are some more words having the same final sound as nag. Read then with me and listen for the final sounds." Again the words appear on the scope as they are aurally presented. Each rhyming example is preceded by a repetition of the word that is being taught: nag, evag; nag, gag; nag, signag; nag, gashag. The student is then requested to touch and say the word nag.

In both the alliteration and rhyming sections, care was exercised to choose words which were unlikely to be in the reading or recognition vocabulary of the student. This was done to assure that the student's attention would be focused on the one recognizable element of the target word, and that his attention would not be divided by any attempt to decode the remaining elements.

Following the alliterative and rhyming sections of this remedial block, each word is imbedded in a semantically enriched sentence. Again using nag as an example, the following sentence appears on the scope. "The cruel queen would nag the princess all the long day." The sentence is read to the student and he is then asked to touch and say the word nag. This type of exercise provides the student with an enriched semantic context for each word and with further practice in identifying the word.

"Rich" Sentences. The presentation of enriched but natural sentences allows the student to hear problem words in a semantically "suggestive" context as well as to gain practice identifying the problem word in a limited response set. The following procedure is used. Two words are presented on the scope at the same time. One of the words is used in an audio sentence and the student is requested to touch and say the word which he heard in the sentence. For example, tag and sag are presented on the scope. The student receives the following audio message, "Look at the two words on the scope: tag, sag", (each word is identified by a cursor as it is pronounced). The student is then requested to "Touch and say tag. Now touch and say sag. One of these words will be in the sentence I am going to read to you now. Listen for one of them in this sentence. 'Your shoulders sag when you don't stand up straight.' Touch and say the word on the scope that you heard in the sentence." Each word in the list is given three non-consecutive presentations in this remedial block.

Reduplication and Sentence Initiator. A teaching technique commonly found in basal reading series is the high repetition or reduplication of words in the quasi-story material. For example the following types of

material are often encountered: "Run, run, Spot. See Spot run. Run, run to Jack." Evidence has recently been gathered (Hansen, in preparation) that such massed practice or reduplication of learning items indeed facilitates word acquisition. The use of the reduplication technique is explored in relation to CAI in this remedial block. For example, three images of the word tag are presented simultaneously on the scope, ([tag tag tag]). The student is requested to "Touch and say tag." When any one of the three displays of tag is touched, it disappears from the scope face. The student is again asked to "Touch and say the word tag." The second touch causes the word to disappear and the student is reinforced by the message, "Good, tag." The final display of the word is then deleted and a very natural but short sentence is displayed (e.g., "It's a tag."). The student is told "Here is a sentence with tag in it. First I will read the sentence, then you read it. 'It's a tag'." The student is then allowed time to read the sentence.

The four blocks of remedial word presentation materials are sequenced after Stage B in the word list presentation block (Figure 2). It will be recalled that in a conventional sequence for the word list presentation block in Stage B (Figure 1), the picture is presented on the projector without the printed word, and a touching response on the scope is requested. A counter is set at the beginning of Stage B so that it tallies the errors for each initial presentation cycle but not the optimization routines. At the end of the first cycle, the counter is examined. If its contents exceed some predetermined value (50 percent of the number of response requests) the student is branched to the first assigned block of remedial material.

After completion of the remedial block, the student is returned for another cycle through Stage B. The error counter is again set to zero and the above operation is repeated. If the student again has an error rate of greater than 50 percent, not including the optimization routine, he is branched to the second assigned block of remedial material. The branching process is repeated if necessary until all four blocks of remedial material have been exhausted. In the case where a student completes

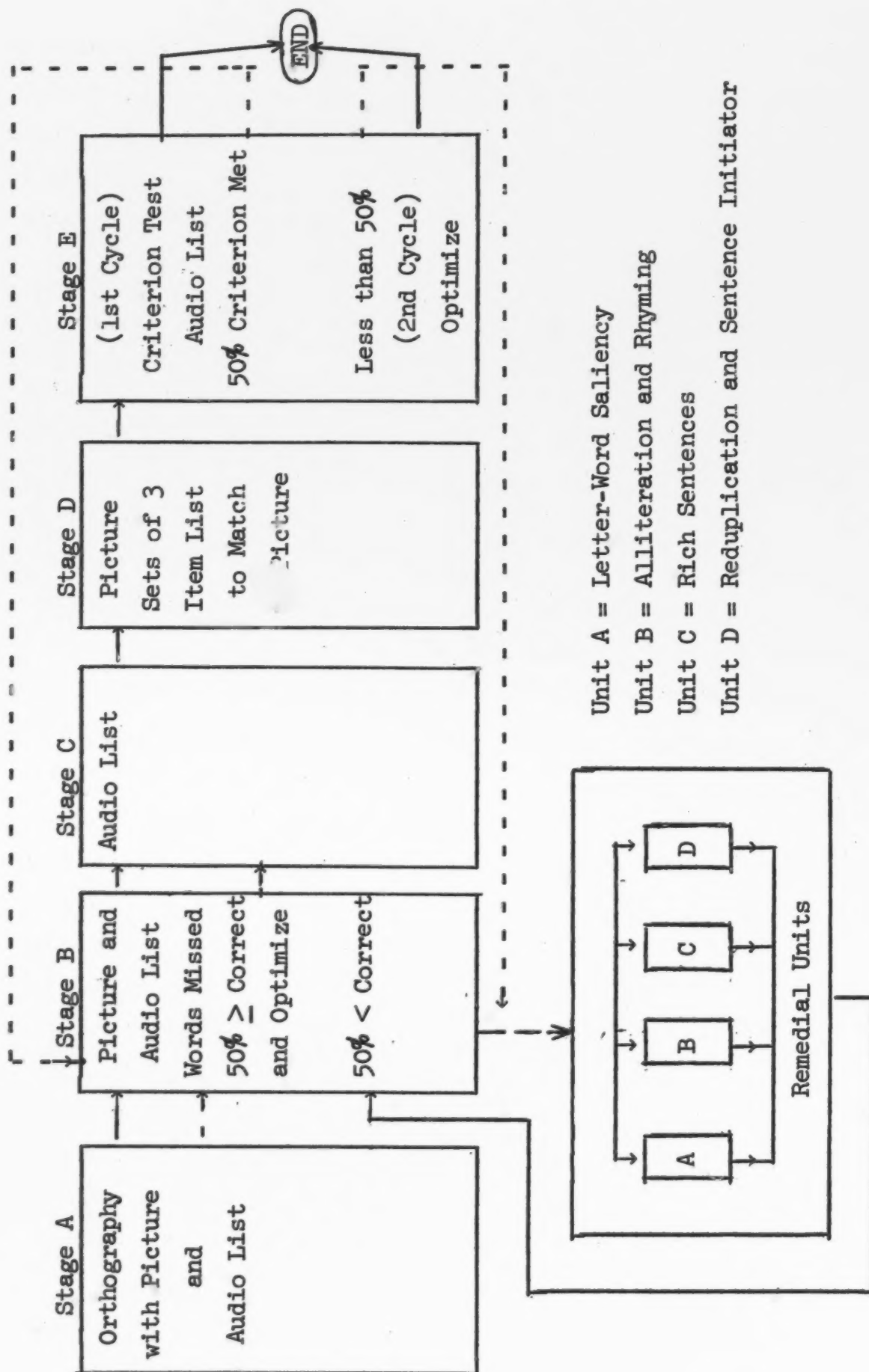


Figure 2
 Word-Picture Flow Diagram With Remedial Units

a fifth failing cycle in Stage B, he is branched out of the instructional material and the proctor is automatically called. It is possible then for a student to receive from zero to four remedial presentations according to the evaluation after a cycle through Stage B.

If a student meets the criterion for Stage B, he proceeds through stages C, D, and E, to the word criterion test. The decision counter is again set to zero at the beginning of the word criterion test. If a student meets the criterion he proceeds to the next section of lesson material. If his performance in the test does not meet the criterion and his error rate is less than 50 percent of the number of response requests, he is branched to Stage B. If, however, the error rate exceeds 50 percent, he is branched directly to the next of the unrepresented remedial sections (if applicable) before being recycled through Stages B, C, D, and E. In a second cycle through Stage E, the student is given an optimization routine and allowed to proceed to the next section of the curriculum. Therefore, there are two ways by which a student can reach the remedial material. The first is to exceed the error criterion for Stage B and the second is to fail to meet criterion during the first cycle of Stage E.

The same general procedures apply to either method of entering the remedial material. It must be noted, however, that only one entrance to the remedial material may be made from the word list criterion test since the second pass through the criterion test is purely an optimization routine with no error counter being set for second branching to remedial loops. An evaluation of the remedial material and the remedial sequence will be made in the following manner. For each word list presentation section (that is to say, for each lesson), the four blocks of remedial material will be randomly reordered. The response data of students receiving remedial material will be subjected to off-line analysis in an attempt to discover if the increments in performance following each of the remedial blocks differ significantly from each other.

Matrix Construction

Certain rhyming and alliterative word patterns can be considered regular because of their high productivity in English in that the isomorphism between symbol and sound sequence is not exceptional. Fries (1963) and Bloomfield (1942), among others, have suggested that such patterned word regularity might be a key concept in learning to decode English print. This decoding concept is implemented in the Stanford materials within the context of Vocalic Center Groups and their sequencing as explained in the Vocabulary Sequence Chart (Table 1). The sounding matrix is an instructional technique which allows for practice in reading rhyming and alliterative patterns.

Rhyming patterns are presented in the columns of the sounding matrix.

	an
r	ran
f	fan
c	can

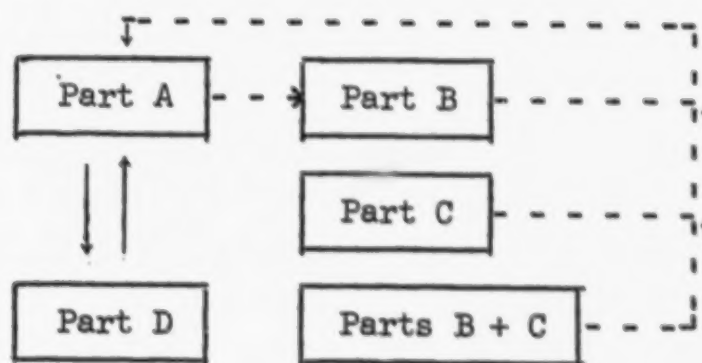
Alliteration patterns are presented in the rows of the matrix.

	an	at	ag
r	ran	rat	rag

The matrix is constructed one cell at a time. The initial consonant of a CVC word is termed the initial unit and the vowel and the final consonant are termed the final unit. A similar division is made when the words are composed of consonant clusters and diphthongs. Each intersection of initial unit row and final unit column determines the entry in any cell.

The problem format for the construction of each cell is divided into four parts: Parts A and D are standard instructional sections

and parts B and C are remedial sections. The following flow diagram indicates that remedial Parts B and C are branches from Part A and are taken independently or in combination.



The following example of a matrix cell construction is presented in some detail in order to highlight the instructional sequence and remedial branches. The student sees the empty cell with its associated initial and final units and an array of response choices. He hears the audio message indicated by RR 1 in the following example.

an
r
rat
bat
fan
ran

(Part A)

- RR 1 Touch and say the word that belongs in the empty cell.
- CA: (Branch to Part D)
- WA 1: No, $\begin{cases} \text{rat} = \text{final} \rightarrow C, \rightarrow A \\ \text{fan} = \text{initial} \rightarrow B, \rightarrow A \\ \text{bat} = \text{other} \rightarrow B, \rightarrow C, \rightarrow A \end{cases}$
- WA 2: No, touch and say $\downarrow$ CA ran.

If the student makes the correct response (i.e., touches ran) he proceeds to Part D where he sees the word written in the cell and receives one additional practice trial.

an
r

(Part D)

- RR 1 Good, you have put ran in the cell. Touch and say ran.
- CA: Good, ran. ($\rightarrow$ next problem)
- WA: No, touch and say $\downarrow$ CA ran.

In the course of an errorless trial the student hears the word pronounced three times and he must identify and pronounce it twice.

In the initial presentation in Part A, the multiple choice items are designed to identify three possible classes or error:

- 1) The initial unit is correctly identified but the final unit is not (Part B);
- 2) The final unit is correctly identified but the initial unit is not (Part C); or
- 3) Neither the initial unit nor the final unit is correctly identified (Parts B and C).

If the student responds with fan he is branched to remedial section B where attention is focused on the initial unit of the cell.

an

r ran

f

r

d

(Part B)

RR 1 Touch the initial unit of the empty cell.

CA: Good.

WA: (1) ($\frac{1}{r}$) No, this is the initial unit of the cell (1') so touch this.

CA $\left(\begin{smallmatrix} f \\ r \\ d \end{smallmatrix} \right)$

→

If a correct response is made, the student is returned to Part A of the problem for a second attempt which will be optimized for a correct response. If an error response is made in Part B, the indicator is displayed above the initial unit beside the cell at the point indicated by the first circled superscript (1) in the audio message and held until the second superscript (1'). At the completion of the response request, the indicator is placed beside the correct response area and held until a correct response is made (CA).

If, in Part A, the student responds with rat, he is branched to remedial section C where additional work is done on the final unit of the cell.

(Part C)

an
r

r

an
at
ag

RR 1: Touch and say the final unit of the cell.

CA: Good.

WA: (1) (

--

) No, an is the final unit of the cell (1) so touch and say

CA
→ (an
at
ag)

The procedures in Part C are similar to those of Part B. It should be noted in the remedial section that the initial letter is never pronounced (Part C) whereas the final unit is always pronounced (Part B).

If, in Part A, the student responds with bat, he is branched through both initial and final unit remedial work. These remedial possibilities should allow for sufficient practice on the word components.

When the student returns to Part A after completing a remedial section, a correct response will advance him to Part D as indicated. If a wrong answer response is made on the second pass, the indicator arrow is placed beside the correct response area and held until a correct response is made. If the next response is still an error, a message is sent to the proctor and the sequence is repeated from the beginning.

When a student has made a correct response on Parts A and D, he is advanced to the next word cell of a matrix which has a problem format and sequence identical to that just described.

(Part A)

an at
r

ran	
-----	--

cat
rat
rag
tag

RR 1: Touch and say the word that belongs in the empty cell, (and so forth).

The individual cell building is continued until the matrix is complete. The majority of the matrices in the lesson material contain from six to twelve words and nonsense syllables. Nonsense words are considered legitimate cell entries under the following constraints:

- 1) Nonsense items are occurrent English syllables;
- 2) Nonsense items are not used which represent "regular" but unconventional spellings for common monosyllabic words. For example, although sed represents a regular spelling for the initial English syllable in words such as sediment, it would not be presented in matrix format since it would be considered an unacceptable spelling for the homophonous monosyllabic word said; and
- 3) The proportion of nonsense words in the matrix is less than 40 percent of the total cell entries.

When the matrix is complete, the entries are reordered and a criterion test over all cell entries is given.

	at	an	ag	Touch and say:
f	fat	fan	fag	RR 1: ran
r	rat	ran	rag	RR 2: cag
c	cat	can	cag	RR 3: rat
				.
				.
				.

The student is required to identify each cell entry in random order. Since the first pass through the criterion matrix is a test trial, no reinforcement or correction is given. Errors are categorized as initial, final, and other. Remedial exercises are provided for both initial and final errors. The branching procedure is similar to that in the cell construction section with the exception that, whereas the branching in the cell construction block was contingent on each separate response, the branching in the criterion test is contingent on the total performance in the test. If the total errors exceed some specified criterion

percentage (e.g., 20 percent) of the total responses, the category registers are examined. If all the errors are recorded in one category (initial, final and other), only the remedial material appropriate to that category (i.e., initial or final) is presented. If the errors are distributed over both categories (initial and final) further remedial material is presented. This material is highly similar to conventional phonics exercises. The following is an example of the matrix remedial material.

Initial Unit Remedial for Matrix Criterion Test

Touch the initial unit of the following:

RR 1: rat

WA: No, this is the initial unit of rat
ICA
(r)
Touch it.

r
f
c

RR 2: can

WA: No, this is - -

RR 3: fan

.

RR 4: cat

.

.

.

.

RR n: rag

Final Unit Remedial for Matrix Criterion Test

Touch and say the final unit of the following:

RR 1: rag

ICA
WA: (ag) No, ag is the final unit of rag. Touch and say it.

an	at	ag
----	----	----

RR 2: fan

ICA
WA: (an) No, an is - - -

.

.

.

.

RR n: cag

.

The standard optimization scheme in which a correct response is obtained for each item is used for each section of remedial material.

After working through one or both of the remedial sections, the student is looped back for a second pass through the criterion matrix. The second pass is a teaching trial as opposed to the initial test cycle; the student proceeds with the standard correction and optimization routines (i.e., only the missed words are presented).

Usage

The "Usage" material is more predominantly semantic in nature. The list of words is displayed on the scope. Definitions are given auditorially one at a time and the student must identify the word that matches each definition by a touch-probe response. The definitions are chosen with the following constraints:

- 1) If the word appears in the Rainbow Dictionary (1959), all the meanings defined in that dictionary must be used.
- 2) If the word does not appear in the Rainbow Dictionary but does appear in the Thorndike-Burnhardt Beginners' Dictionary (1964), at least one of the definitions must be used. The choice of usage is governed by the criteria of frequency and usefulness in story material.
- 3) If the word definition does not appear in either dictionary, it will not be included in the usage section nor this definition used in succeeding lesson materials (e.g., sentences, stories).

A strict "dictionary definition" format is avoided in defining word items. Standard definitions have been re-constructed so as to stress functional meanings. This re-construction can be seen in the following example. For the word bat one dictionary definition is, "a stout wooden stick or club, used to hit the ball in baseball, cricket, etc." In the lesson materials this is reformulated in the following instruction: "Touch and say the word that means something you might use to hit a baseball."

A correct response is reinforced by confirmation of the functional definition, "Yes, you hit a baseball with a bat." An incorrect response is corrected in a straightforward manner, "No, you hit a baseball with a bat. Touch and say bat." Thus, for an initial correct response the definition is associated with the word twice. For an initial incorrect response, the definition is associated with the word three times since the student will receive the re-inforcing confirmation after his correct response has been made. No branching or optimization routines are employed in the usage section.

Form Class

As part of the concept of "comprehension" of a sentence, one must consider the child's basic understanding of English syntax. One behavioral

manifestation of a child's syntactic sophistication is his ability to functionally group words into common form classes (nouns, verbs, modifiers, etc.). This section provides lesson materials that both assess and teach the form class characteristics for the words just presented in the matrix section.

The following type of problem is presented to the student:

Dan saw the	tan	hat.
	fat	
	man	
	run	

Only one of the words in the column will make sense in the sentence. Touch and say the word that belongs in the sentence.

CA: Yes, Dan saw the tan hat.
Do the next one.

WA: No, [↓]tan is the word that makes sense.
Dan saw the tan hat.
Touch and say tan.

The sentence is composed of words that are in the well-practiced reading vocabulary of the student (i.e., they have been presented in previous or current lessons). The elements of the multiple choice set include a word which is of the current form class but semantically inappropriate, two words that are of the wrong form class, and of course the correct word. A controlled variety of sentence types is employed and the answer sets are distributed over all syntactic slots within each sentence type.

Response choices are categorized in rather broad terms as nouns, verbs, modifiers, and other. The response data are examined for systematic errors over a large number of items. Examples of the kinds of questions that will be asked of this data are:

- 1) Are errors for various form classes in various sentence positions similarly distributed for a given student? for the general population?
- 2) How are response latencies affected by the syntactic and serial position of the response set within the sentence? by the sentence type? by sentence length?

Answers to these questions and others of a similarly general nature should provide information that will permit more systematic study of the relationship of sentence structure to reading instruction.

Inquiries

Individual words in sentences constitute unique and conversationally correct answers to questions. These questions take the interrogative form "Who - - -, What - - -, How - - -," etc. The ability to select the word in a sentence that uniquely answers one of these questions demonstrates one form of reading comprehension at the level of the sentence. The set of exercises described in this section constitutes an assessment of this reading comprehension ability.

John hit the ball.

Touch and say the word that answers the question.

RR 1 Who hit the ball?

CA: Yes, the word "John" tells us who hit the ball.

WA: No, John tells us who hit the ball. Touch and say John.

RR 2 What did John hit?

CA: Yes, the word "ball" tells us what John hit.

WA: No, ball tells us what John hit. Touch and say ball.

As in the form class section, each sentence is composed of words from the student's reading vocabulary. A wide variety of sentence structures are utilized beginning with simple subject-verb-object sentences and progressing to structures of increasing complexity. The data will be examined for effects caused by the different sentence types. In an alternating sequence, sentences used in the form class section of one lesson are used in the inquiry section of the next lesson. Using this system of alternation we can examine any possible effects produced by previous practice.

Rhymes

Rhymes are sequenced into a lesson as a listening activity to help the child develop competency in the discrimination of the rhyming and

alliteration sounds of words and to demonstrate to the child the rhythmic use of language. The selection of rhymes for each lesson is based upon the sound patterns found in the matrix section of the lesson.

The lessons employ three types of rhyming material:

1) Traditional nursery rhymes:

Example: Peter, Peter, pumpkin eater.

Had a wife and couldn't keep her;
He put her in a pumpkin shell
And there he kept her very well.

Peter, Peter, pumpkin eater,
Had another, and didn't love her;
Peter learned to read and spell,
And then he loved her very well.

This rhyme is used in the lesson teaching -ell spelling-sound correspondences.

2) Original rhymes written by members of the writing group to illustrate other word patterns:

Example: "There's no flaw in my shell," said the crab.

"Still the animals say that I'm drab.

I do not agree! When I look at me,
I see a most handsome, sweet crab.

I've a claw that can grab very well.
And my smile casts a magical spell.

The girl crabs confess
They adore how I dress,
And they swarm at my sea-fishy smell.

My eyes have a sparkle like glass.
My shell is as strong as hard brass.

They're jealous of me
When they look and see
Such beauty combined with such class!"

This rhyme is used in a review lesson following lessons that introduce the -ell, -ess, and -ass correspondences.

One or the other of the rhyme types is used in every lesson through Level III. From Level III' on, the rhymes are used in approximately every third standard lesson and in every review lesson. In later sections these rhyme types are further restricted to review lessons.

- 3) Original nonsense rhymes (doggerels) are in every standard lesson starting with Level III. These rhymes use each word presented in a given lesson and are intended to review the correspondence patterns of earlier levels. The doggerels all have a standard beginning and end, (i.e., the first two and last two lines).

Example: Higgledy, piggledy, my fat hen,
Wants to hear these words again:
If I ran away, I fled,
If I speeded, then, I sped.
When I cut myself I bled,
An eskimo rides a sled.
A good name for a boy is Fred,
These new words fill up my head.
Rhyme time's done, I must away.
I'll be back another day.

In the later portions of the reading materials (after lesson 200), the children are presented with lesson units on poetic and figurative language. (This poetic material is presently being written.) The poetic sequence demonstrates similes, proverbs, parables, analogies, and metaphors (in that order). The purpose of the poetic material is to increase the children's awareness and enjoyment of competency over rhythmic and highly symbolic reading material.

Games

Games are sequenced into each lesson primarily to encourage continued attention to the lesson materials. The games are structured to those played in the classroom and utilized the terminology common to game-like situations such as baseball or bingo. In addition, each game has been structured so as to reveal any developing linguistic competency on the

part of the child. For example, one game is centered on the child's ability to identify a given string of letters when presented in a concept-identification paradigm. The question of how children come to see orthographic commonalities is relatively unexplored, and the game is intended to provide us with some basic information with which we can more precisely direct our thinking. Moreover, the games give the children added practice on the sequenced vocabulary. During feasibility studies of the curriculum, we found that the children were more willing to practice vocabulary items in a game-like situation rather than the word list or matrix presentations.

The following is a brief description of the games, their intended purposes, and their rules. A precise assignment of game according to lesson numbers can be found in Appendix G

"Find the Rule Game." This game is intended to discover how children identify letter sequences in words. The child is presented with two words, such as cat and ran. He is requested to guess "which word I am thinking of." He is then told that "there is something alike about the words which I'm thinking about" and that he should try and choose them. At this point he has no clue to the solution of the rule. After he responds, he is told which word is correct, so that if cat was correct in the first example, bat would be correct in the pair bat and bag. He is presented with a total of ten such word comparisons. To win the game he must meet a criterion of five consecutive correct responses. If he does not meet the criterion at the end of the ten pairs, the pairs are re-randomized and the child is presented with additional clues, that is, an underlining of the common printed portion in each successive pair. After he has successfully completed the game, or if he has not met criterion, he is given the solution; for example, he is told, "all the words with 'at' are the ones I was thinking of." This game is used to emphasize both initial and final letter strings as well as morphemic endings.

Vowel-Contrast Game. This game was intended to develop the children's auditory discrimination and identification of vowel sounds. For example, two vowel letters such as i and a are presented on the scope. A word like cat is pronounced to the child and he is requested to touch the letter on

the scope which designates the middle sound of the word. If his response is correct, the word appears on the top of the scope. If it is incorrect, the word is placed in a bottom portion of the scope. At the end of the sequence of words, a comparison is made of the two lists and the longer list indicates the winner. It is to be noted that most of the games represent a competition between the child and the personified computer.

How Many Stars Can You Get? This game is intended to focus on form class and syntax ordering in English sentences. Four strings of words are presented on the scope. Repeated arrays of words are presented, and it is the student's task to sequentially touch words in order to generate a correct sentence. The student is requested to choose the string which makes a correct sentence. For each correct response he gets a star. At the end of the game, his score is equal to the number of stars he has.

The following games have been created to give the children additional practice in word decoding, rhyming relationships, and word meanings. Although the games are similar in purpose, they vary greatly in form and, therefore, provide the children with a variety of learning activities.

Baseball. A list of words and a baseball diamond are presented on the scope. A word meaning for one of the listed words is auditorially presented to the child and he is requested to touch the word that goes with the meaning. For example, "a four legged hairy animal that goes meow" would go with the word cat. If the student is correct, he gets a hit, and a base-runner moves to first base. If he is incorrect, an "out" is indicated in the score box. Four hits make a win and three outs lead to a loss for the game.

Hopscotch. A hopscotch design with a footprint and a list of words is presented on the scope. With each correct answer, the footprint moves through the hopscotch pattern. Again, either a pronunciation or a word meaning is presented to the child and he must respond by touching the correct word. If he has not reached the end of the hopscotch pattern at the end of the list of words, he is told that the game is over.

Bingo. A 5 x 5 bingo board is displayed with a word in each cell.

The game again is intended to focus on word decoding and rhyming relationships. A word is pronounced and the child is to touch the cell where it belongs. For each correct answer the given word disappears from the cell. The child is presented with a clue to the correct answer. When a complete row, column, or diagonal is empty, the child wins the game.

Go-Cart Race. A list of words and two small carts are presented on the scope. One cart is the child's and one cart belongs to the computer. For every correct answer the child's cart moves ahead and for every incorrect answer, the computer's cart moves ahead. The owner of the cart farthest ahead at the end of the list of words is the winner.

Darts. A list of words, a dartboard, and a dart are presented on the scope. For every correct identification of a word the dart moves toward the bull's-eye position on the target. For every incorrect answer, the dart drops down one level and away from the center of the target. If the child gets all of the words correct, the dart hits the bull's-eye on the final response. If he has made only one or two incorrect responses, the dart hits the outer rings of the target. If he has made more than a criterion number of incorrect responses, the dart hits outside the target.

Draw a Boy. A list of words is presented on the scope. For each correct identification of a word, a part of a boy appears on the projector. If the student gets all the words correct, a whole boy finally appears and the child wins.

The Monkey's Playmates. A list of words is presented on the scope and a picture of a monkey in a circus wagon is presented on the projector. For each correct word identification the child makes, another animal appears in the wagon with the monkey. If the child gets all the words correct, the wagon is full of animals and the child wins the game. If the child misses some words, the wagon is only partially full at the end of the game.

Riddle Game. This is a slightly more complex form of word decoding and word identification. Two score boxes and a list of words are presented on the scope. A riddle is given to the child and he must choose the correct word on the screen that will answer the riddle. For each correct answer, a star goes into the student's score box. For each incorrect answer a star goes into the computer's score box. The one with the most stars at the end of the game wins.

As indicated earlier, all of these games are intended to provide the children with intrinsic motivation to continue practicing much of the same material that has previously been presented. Ordinarily the words found in the games were introduced in the preceding lesson. This provides, we believe, sufficient practice so that the children may build appropriate competencies. Again it is to be noted that the responses in the game sections can be analyzed just as paired-associated items or as concept-identification items in more controlled psychological experimentation.

Compound Words

Our approach to compound words assumes the existence of a learning-transfer process in which the child knows how to read one of the two elements that form the compound word. The learning task consists of reviewing this known word and learning the unknown part of the compound. In addition the child must comprehend the conventional meaning of the compound word as well as its role in a fairly rich sentence. Thus we are utilizing compound words to study the degree to which children can transfer partial reading mastery (i.e., mastery of one of the two words in the compound) to a variety of reading contexts.

Compound words are introduced in Level III and are initially composed of two known monosyllables (e.g., bat and man are mastered prior to the presentation of the compound batman). We then introduce sequences of five compound words in which only one of the elements is known. Words are selected according to the following three criteria:

- 1) frequency in initial reading materials.
- 2) imaginative possibilities so that semantically rich context sentences may be written, and
- 3) the opportunity to vary the known word in initial and final position in the five compound words (e.g., hatbox, firehat, hatband, etc.).

Each compound word is sequenced through five learning steps as follows:

Step 1. In the first step, the child's attention is focused on the new compound word and its components by a simple predicate equivalent

sentence structure, of the form, "A Word₁ + Word₂ is a Word₂ (in, of, for, etc.) a Word₁. To illustrate using the compound word hatbox, the initial sentence presented on the scope is

$wd_1 + wd_2$ is a wd_2 (in, of, a wd_1 .
for, etc.)
A hatbox is a box for a hat.

An illustration is presented on the projector and the compound word is underlined on the scope. The sentence is read to the child and he is requested to "touch and say" the compound word.

Step 2. The compound word is presented in a semantically rich sentence that provides a vividly striking context. In order to make the word more salient and to make the task more enjoyable, the sentence is often humorous and provides information with which the child can answer a question. To illustrate, a sentence like "The goat is dining on Mother's red hatbox" is presented on the scope and then read to the child. Again he is requested to "touch and say hatbox."

Step 3. The two words composing the compound are presented on the scope with adequate spacing between them. The child is requested to touch and say hat and then box.

Step 4. The current compound word (e.g., hatbox) in addition to the two other compound words (e.g., hatband, firehat) are presented on the scope and the child is requested to touch and say hatbox.

Step 5. A simple, readable question is presented on the scope and the child is directed to read it. To illustrate with the sample sentence presenting hatbox, the question "What is red?" is presented and the audio direction is "Here is a question for you to read." An obvious answer is then presented on the scope such as "Mother's hatbox is red." This is followed by the audio direction "The question was 'What is red?' Read the answer." And finally, the audio message "Mother's hatbox is red. Touch and say hatbox" is presented.

This procedure was derived from a series of feasibility studies performed by six year old children. The sequence of compound words is given in Appendix D.

Polysyllabic Words

Our approach to polysyllabic words focuses primarily on the role of stressed syllables as they relate to both rehearsal and memory processing. We hypothesize that polysyllabic words with stress on the first syllable and a neutral vowel such as schwa (ə) in the final syllable will be more easily learned. In the Stanford Reading Curriculum the acquisition of polysyllabic words is, as with compound words, a transfer learning process in which the first syllable of a polysyllabic word follows the pattern previously taught in the word list and decoding exercises. The stress and the number of syllables involved in the sequence are tightly controlled. The precise rules for sequencing polysyllables are as follows:

- 1) the words are, at first, bi-syllabic,
- 2) the first syllable of the word is stressed,
- 3) the vowel of the final syllable is represented as phonemic /ə/, excepting /ɪə/, /li/, /is/, /l/,
- 4) the first syllable is regular in that it follows the pattern learned in the word list and matrix exercises,
- 5) the word is monomorphemic where possible, and
- 6) the words are found in the Lorge-Thorndike Word List (1944).

Utilizing these rules, the following unstressed second syllables (shown in Table 2) were added to an appropriate vocabulary item to form a polysyllabic word. In a real sense, the syllables in Table 2 form most of the predominant suffixes in English.

Polysyllabic words are first introduced in Level III'. The precise sequencing first involves double rhymes in which the words for a list in a given lesson are both graphemically and phonetically correlated except for the initial consonant (e.g., bitter, litter, etc). Subsequently, words are presented in which all the second syllables both rhyme and remain morphemically constant (sapling, starling). They may or may not be morphemic units (letter, batter). In general, polysyllabic words that are of high frequency and are useful for the story material were selected. We assume that the words are understandable to the children, although no semantic criteria were specified. A list of the

Table 2

Initial Syllable + @C					Stem + V	Stem + CV	Stem + C@C
ad	<u>ed</u>	id	oc	ul	y	ly	don
*age	el	il	ock	ule			ful
*al	le	in	ol	un			less
an	en	<u>ing</u>	on	ure			let
an	*en	sion	on	us			ling
<u>ance</u>	*ent	<u>tion</u>	op	ut			ment
*ant	*er	ir	*or				ness
or	et	<u>ish</u>	ot				ward
ask		it	our				
<u>ate</u>		<u>ive</u>	ours				
			ous				
* Indicates syllable may be a morphemic or a non-morphemic element. _____ indicates the final syllable is a morphemic element.							

polysyllabic words presented in the reading materials can be found in Appendix E.

The lesson structure for polysyllabic words consists of a sequence of approximately five words. For each pattern type (double rhyme, second syllable rhyme, morphemic second syllable and/or non-morphemic second syllable) the child is given a screening test similar to the matrix built vocabulary screening test. The child is asked to touch the cell where the two elements joined together such as lad + der forming ladder belong. Should the child be unsuccessful, he is presented with a rhyme utilizing the words from the screening test, followed by simple phonetic-graphemic decoding exercises adjusted to that particular pattern of polysyllables. The child performing successfully on the screening test, and the child who has been presented with the phonetic-graphemic exercises then proceed to a lesson utilizing two words from the screening test and three to four others which follow the pattern being presented. Each word goes through five presentation steps similar to those for compound words.

Step 1. A question involving the polysyllabic word is presented on the scope. For example, in presenting the word little, the question "Who's little?" appears on the scope. The student is directed, "Read the question with me and touch and say 'little'." In this initial step the polysyllabic word little is underlined.

Step 2. In step 2 the child is asked to read an answer to the above question; the answer provides a rich semantic context for the polysyllabic word. For example, a potential answer for little is "Tim is not tall. Tim is little." The audio message would be: "Here is an answer. You read it by yourself." After a brief pause, the child is directed to "Touch and say 'little'."

Step 3. This step involves a segmentation of the syllables in the word. Typically the first syllable is presented by itself (e.g., lit appears on the scope). The child is directed to "Touch and say 'lit' to make 'little'." When the child responds, the word little appears on the scope.

Step 4. The polysyllabic word is sequenced into a set of multiple

choice items within a sentence such as in the example, "Tim lit the ladder bitter little lamp." The child is told to "Touch and say the word that makes sense in the sentence." The two incorrect choices involve possible semantic or phonological confusions.

Step 5. In this step the polysyllabic is imbedded in a rich context and the child is again expected to touch and say it. For example, the sentence "I'd like a little bit of butter on my bread" appears on the screen and the child listens to the sentence and is directed to "Touch and say 'little'."

As is evident in Appendix E, the sequence of polysyllabic vocabulary allows for a build-up from two to three syllable words. There are direct systematic variations given between monomorphemic and polymorphemic word entries. All of these variations will be evaluated for their influence on the learning process.

Sentence Initiators

In reading written discourse, our learning objectives is to train the initial readers to pronounce sentences with conventional intonation. A common reading behavior for beginners is giving "final word stress" to each of the words in a sentence (e.g., reading That Is A Fan instead of "That's a fan."). We wish to teach the child to adjust his timing, pitch, and stress contours so as to read sentences with intonation patterns commonly found in speech. This learning task takes on significance when one becomes aware that no speech analysis device is a part of our CAI system nor is even technologically available at this time. We depend upon our initial reader to be the speech analyzer in this section of the Stanford Reading Lessons.

We do have available one of the important features of any CAI system, namely, the precise control of the timing of all learning events. The virtue and logistic nuisance of a CAI system is the required specification of all the time intervals for each of the instructional and reinforcement events within every problem. In this as well as other sections of the lessons, we utilize the pacing feature of the CAI system to accelerate

the reading-speech output of the children and, consequently, cause the children to approximate the speech and prosodic features of normal speech while reading.

Our choice of learning materials facilitated, we believe, the attainment of our learning objective. We maximized the expectancy of conventional sentence intonation by selecting high frequency sentence components such as "it's a," "That's a," "They can," etc. that are utilized commonly in the introduction of high frequency nouns and verbs in speech. These high frequency initiating sentential strings were selected from Carterette's (1965) list of multi-word units that were uttered by six-year-old children during a free discussion session. It is to be noted that these word strings are pronounced by the children as if they are polysyllabic words. In addition, young children's use of these sentence initiators is strikingly parallel to the use of pivot words by two-year-olds as discussed by Brown and Fraser (1963). To each sentence initiator we attach a noun or a verb that the children have previously learned in the list and matrix sections of the lessons. This provides us with an opportunity to review these words.

After a number of pilot investigations that focused on the timing of the learning events, we found the following experimental procedure to be most promising in terms of achieving our objective. The sequence of the procedure is as follows:

- 1) anticipation interval: a sentence appears on a display device and the child is given two seconds with which to attempt an oral reading,
- 2) reinforcement interval: the audio device then plays a reading of the sentence to the child, and
- 3) modeling interval: the child is given $3/4$ of a second to repeat the reading of the sentence. For each new sentence the cycle is repeated.

In reinforcement terms, the child is expected to use self-evaluation in order to note any discrepancies between his reading and the machine's reading. A study (Hansen, 1966) empirically confirmed the learning feasibility of the timing intervals and problem structure.

Each exercise in the "sentence initiator" section contains 25 sentences. Each initiator is presented approximately five to ten times in a given lesson and for a total of 100 to 125 exposures in all the lessons. At this point, the sentence initiator is utilized in the story material. The following is an example of the manner of presentation of the sentence initiator material. Sentences appear separately to match the audio messages. The numbers do not appear on the scope.

- | | | |
|-----------------|----------------------|----------------------|
| (1) She's lame. | (9) That's a flame. | (17) They can date. |
| (2) She's tame. | (10) That's a frame. | (18) They can name. |
| (3) She's thin. | (11) That's a name. | (19) They can blame. |
| (4) She's slim. | (12) That's a game. | (20) They can bet. |
| (5) He's wet. | (13) That's a clip. | (21) They can beg. |
| (6) He's sad. | (14) That's a chip. | (22) They can bat. |
| (7) He's mad. | (15) That's a trip. | (23) They can pat. |
| (8) He's glad. | (16) That's a snip. | (24) They can wag. |
| | | (25) They can brag. |

The manner of presentation of the sentence initiators allows the student to monitor his own production by comparing it with the audio model. Additional monitoring of the student's performance in the sentence initiators material will be accomplished by the proctors and by sample recordings made on a separate recording system (this being subjected to off-line analysis).

Adverbial Sentence Initiators.

In Level IV the purpose and format of the sentence initiators exercises have been expanded to include adverbial modifiers. The exercises in Level I, II, and III exposed the reader to short, grammatically simple sentences which he read aloud. The purpose of the adverbial exercises is to continue to teach sentence intonation, and, in addition, to teach the intricacies of English syntax through the insights gained when adverbials, as modifiers or phrases, are transposed into appropriate sentence positions. Sentence initiators up to Level IV have used only one type of constituent modification, namely, modification of nouns in the object position by one-word adjectives,

possessives or determiners. Thus, the introduction of adverbial elements offers three new variables:

- 1) greater sentence length,
- 2) adverbial modification of the basic sentence structures, and
- 3) the use of adverbial prepositional phrases.

These adverbial elements offer the student special reading-comprehension tasks because they can occur in several places in a sentence and, consequently, receive a variety of intonations. And yet, adverbials retain very much the same meaning when transposed in the sentence. For example, the sentence, "They had a dog," when modified by either a one word adverb or a single prepositional phrase can appear in quite a variety of patterns, all of which express the same idea:

- | | |
|---------------------|-----------------------------------|
| 1. adv, S, V, O, pp | Often they had a dog in the car. |
| 2. S, V, O, pp, adv | They had a dog in the car often. |
| 3. S, adv, V, O, pp | They often had a dog in the car. |
| 4. pp, S, adv, V, | In the car, they often had a dog. |
| 5. adv, pp, S, V, O | Often in the car, they had a dog. |

Two more syntactic combinations are possible by simply changing the vocabulary.

- | | |
|---------------------|--|
| 6. S, V, O, adv, pp | John eats lunch usually at noon. |
| 7. pp, adv, S, V, O | At night sometimes they watched stars. |

The examples above are all active sentences in the simple present or past tense. The future tense with the more common modals offers an additional syntactic pattern.

8. S, $\left| \begin{smallmatrix} \text{Modal} \\ \text{Aux} \end{smallmatrix} \right|$, adv, V, O, pp They $\left| \begin{smallmatrix} \text{can} \\ \text{will} \end{smallmatrix} \right|$ probably watch stars from the car.

For this material it is convenient to think in terms of syntactic slots in the basic sentence. These slots are places before, between, or after the subject, very and object where adverbial constructions can be placed. Thus, the active voice for a declarative sentence in simple present and past tenses has three slots.

1 S 2 VO 3

Periphrastic or modal tenses create an additional one.

1 S 2 Modal
 Aux 3 VO 4

Active-voice, negative sentences are four-slotted. (Technically there is also a slot between V and O, but adverbial modification in this position is rare except in literary English. In as much as this program is designed for beginning readers, we have ignored this syntactic possibility.) It is clear, then, that the so-called simple sentence modified by just two adverbial elements is not at all simple in view of the variety of possible linear arrangements; there is a variety that is not only common in speech but is especially common in supposedly "simple" children's literature.

The underlying rationale of the adverbial exercises is one of indicating to the reader, with functional examples, the influence of syntactic expectations on reading comprehension. While these syntactic expectations and constraints are imbedded throughout the Stanford reading curriculum we view the development of syntactic competencies in reading as a transfer process from verbal language habits and patterns. In stimulus terms, the rationale says that syntax is a complicating component far beyond word-by-word decoding. For example, if the reader expects to find the subject as the first element in the sentence, then this expectation will be thwarted if he initially encounters an adverbial element instead of a noun-subject. Since these simple adverbial modifiers can occur in such a variety of slots and patterns within the written S V O syntax, insights can be gained from extensive exposure to them.

This rationale in turn has lead to several more specific hypotheses. It is assumed that longer sentences are harder to read than short ones. The addition of adverbial modifiers should be an effective learning device for gradually increasing sentence length and linear complexity. We also hypothesize that adverbial modifiers are a "natural" form of syntactic complexity: that is, adverbs and prepositional phrases expressing time, place, frequency and manner are common in the speech of first graders. Hence, sentences expanded by adverbial modifiers are likely to approximate natural language as the reader knows it. A counter-hypothesis is that

syntactic complexity is strictly a matter of depth in terms of levels of analysis (see Chomsky, 1965). For example, a sentence using a subordinate clause would be more difficult than a sentence of equal length using only simple adverbial modification. We are testing these two views within the Stanford Reading Curriculum.

Given an understanding of adverbial modification, we also hypothesized that the reader will be able to transfer his ability to decode the adverbially modified S V O frame to other adverbially modified frames as expressed in a variety of linear and complex arrangements, specifically:

S V	Sam sang. Yesterday Sam sang in the park.
S V (seem) adj	He seemed sick. Last night he seemed sick at the party.
S V (give) IO O	He gave me a book. He always gave me a book after class.
S V (be) adv	He is here. Usually he is here on time.
S V (be) adj	He is grouchy. Before breakfast he is usually grouchy.
S V (be) N	He is a clown. He is always a clown in class.

The transfer hypothesis is tested at the end of Level IV'.

There are several new purposes, then, for the sentence initiator exercises in Level IV. We want to expose the reader to a sentence complicated by adverbial modification and to familiarize him with many English sentence permutations. Even though these permutations demand different intonation patterns, the differences, at least in a context-free situation, do not alter the meaning of the sentence.

Several constraints were imposed on the writing of the learning materials for the Adverbial Sentence Initiator sections. Each exercise uses only the S V O sentence frame and the same vocabulary and related semantic meaning is used throughout any one exercise. The vocabulary in the frames has been previously learned in other sections. The S V O sentence frame has been previously used in the sentence initiator activity. Thus, the new elements are the adverbs themselves and their positional permutations. Since the adverbs have not been previously taught, the set of three adverbial words is introduced in a list-learning mode before each exercise.

These same adverbs are used again in IV' in the four-slotted exercises.

We have selected only those high frequency adverbs that we intuitively feel are common in ordinary conversation. Many are tri-syllabic, such as yesterday. This is a departure from the vocabulary controls imposed in the rest of the curriculum. These high frequency adverbs defy classification either phonotactically or morphologically. Consequently, the presentation sequence is not ordered by CVC pattern (Vocalic Center Group) as it is in the matrix exercises. These adverbs are further complicated by the fact that they do not follow a regular system of positional patterns within the S V O sentence. For example, one can say, "John had a dog yesterday" but not "John had a dog never." Both yesterday and never are adverbs but obviously they do not have the same syntactic potential or permissibility. For this reason the adverbs are grouped more on the basis of convenience and permutational characteristics. For example, once, later, and angrily fit in identical slots and are taught in the same lesson. Many high frequency adverbs are adjective-noun pairs which have adverbial permutational characteristics and are pronounced as one. For example, last night, last week, and last month are presented together and used throughout one exercise.

The order of presentation within a lesson is as follows. The new adverbs are presented three at a time immediately before each sentence initiator exercise. The list-learning format is the one used to introduce function words in Level III'. For the sentence initiators, there are twenty-five sentences that utilize the three adverbs. Each set is list taught and then used in the exercise. The explicit schedule within any one lesson is as follows:

I. Present basic sentence frame "The man fed the pig."

II. Present frame with one adverb:

In slot 1 Usually the man fed the pig.

In slot 2 The man usually fed the pig.

In slot 3 The man fed the pig, usually.

III. Present the same frame with the second adverb and permute through slots 1, 2, and 3.

- IV. Present the same frame with the third adverb and permute 1, 2, and 3 again.
- V. Present the basic frame with the prepositional phrase and permute it through slots 1 and 3.
- VI. Present the same frame with the first adverb and the prepositional phrase. Permute this one adverb and the prepositional phrase through the three, four or five most likely permutations:

Slots 1, 3	adv, S, V, O, pp	Usually the man fed the pig at bedtime.
Slot 3	S, V, O, pp, adv	The man fed the pig at bedtime, usually.
Slots 2, 3	S, adv, V, O, pp	The man usually fed the pig at bedtime.
Slots 1, 2	pp, S, adv, V, O	At bedtime the man usually fed the pig.
Slot 1	adv, pp, S, V, O	Usually at bedtime the man fed the pig.
Slot 3	S, V, O, adv, pp	The man fed the pig usually at bedtime.
Slot 1	pp, adv, S, V, O	At bedtime, usually, the man fed the pig.

- VII. Present the same frame and prepositional phrase with the next adverb and permute as in VI.
- VIII. Repeat VI, using the third adverb.

In Level IV' the four-slot sentence (those using the future and modal tenses and the negative) is presented. Its presentation follows the steps outlined above with the additional presentations for:

Slots 1, 4 At bedtime, the man will probably feed the pig.

Prepositional phrases typically do not fit into the fourth slot, that is, between the modal or auxiliary and the verb. At the beginning of Level IV, the student is expected to decode only the S V O sentence as in, "He met the trapper." By the end of Level IV' he is expected to decode a sentence such as "Tomorrow he will not meet the trapper on the stage."

In these sentence permutations the question of grammaticality eventually arises. Hypothetically, the following sentence is possible in

English, "John at noon seldom ate his lunch." However, it strains the ear and doesn't sound like the language of a primary grade child. Whether or not to use a particular combination has been left up to the judgement of the lesson writer, in as much as formal grammar has little to say about this gray area between grammaticality and nongrammaticality. To repeat an idea stated earlier, the positional permutations outlined above are hypothetically possible but the exercises use only those permutations which seem likely and natural.

Since the sentences are context free, it is sometimes impossible to determine whether a construction is genuinely adverbial. For example, in the sentence, "Jim fed the dog in the cage," it is debatable whether or not "in the cage" is adverbial or adjectival. For the purposes of these exercises, any construction which can be construed as adverbial and which follows adverbial permutation shall be considered adverbial. Nor is there any restriction upon those few words that can be used both as adverbs and as prepositions. The word before is a case in point. For example, "He saw the dog before," and "He saw a dog before the store," use the word before in two different form classes. This interchangeability has not restricted our use of the word both as an adverb and as a preposition. With these pragmatic solutions we have written an extensive array of sentence exercises. We plan to expand this approach until we have covered the dominant syntactical structures in English.

Stories Read to the Children

From the very beginning lesson the children have an opportunity to listen and react to children's literature. The literature has been organized in story form for the following purposes:

- 1) to expand and widen the children's literary experience,
- 2) to indicate how the rhythm and flow of language is consistent with the thematic material,
- 3) to improve the children's listening comprehension in order to compare it in future points with the children's reading comprehension, and
- 4) to receive the children's reactions to such variables as

- a) thematic content of the story,
- b) length, and
- c) style (narrative versus expository form).

This last variable strikes us as being quite important in that almost all children's stories are presented with narrative ("Father says, Mother says, the animals says," etc.) as opposed to expository material which forms in turn the predominant style of the children's reading material in the intermediate grades. The hypothesis has been put forth that expository material may be both easier and more meaningful for the children to listen to and to ultimately read.

In light of these considerations, stories were selected according to the following criteria:

- 1) simplicity of vocabulary,
- 2) simplicity, appropriateness, and clarity of plot, experiential context, and characterization of the involved persons,
- 3) enjoyment created by catchy phrases, repetitions of sounds, words, or actions, imaginative situations and humor,
- 4) appropriate endings to the story,
- 5) story length,
- 6) relevancy to the children's age level and interests as represented by similar materials found in libraries or television programs, and
- 7) the Project staff's literary rating of the material.

For the purposes of analyzing the reactions and behavior of the children, the stories have been categorized into 5 groups:

- 1) folktales,
- 2) myths, legends, and fables,
- 3) non-fiction,
- 4) poetry, and
- 5) modern fiction.

One of these types of stories is sequenced at the end of each lesson and the child is given a chance to react to different literary forms. At the end of each story, the child is asked to rate it positively or negatively as well as answer certain questions. Beginning at Level III, the

child is allowed in every fifth lesson to choose one of the four preceding stories that he liked best.

In the actual lesson format, the story is presented on the scope so that the child can follow the print as it is read to him. The presentation makes use of an indicator like a bouncing ball. Pictures are presented with stories if the Project staff believes the children need help in understanding certain concepts being presented. Naturally some stories are illustrated while others are not. With the variation, the data can be appropriately analyzed as to the impact of illustrations.

At the completion of each story, the following types of questions are asked:

- 1) subjective ratings as to the positive or negative reactions,
- 2) specific questions on factual identification of characters or events in the story,
- 3) identification of the main theme of the story,
- 4) identification of the appropriate sequencing of events,
- 5) ratings as to the reality orientation of the story,
- 6) questions on imagination and sensory relationships of the story to the child's experience, and
- 7) questions which are idio-syncratic to certain stories in that they express unique features of the content.

In a given story only some of these questions are employed; we, in essence, let the content of the story determine the type of questions asked. The number of questions also varies although typically there are approximately five questions per story. A complete list of the stories read to the children can be found in Appendix H.

The following is an example of a narrative story, "The Festival of Dolls," SRA (1961) which was rewritten in expository style. Every fact contained in the fictional version was included in the expository form. No new information was added, but fictional characters were rearranged as necessary.

THE FESTIVAL OF DOLLS
SRA 16 Starter, Lab 1a

Mioshi was very happy. Soon it would be her birthday. It would be all her friends' birthdays, too! This was not Mioshi's real birthday. But all the girls in Japan would celebrate their birthdays at the same time. It was the Festival of Dolls.

Mioshi thought that it was fun to have the same birthday as her friends. There were always many parties. Mioshi could wear her pretty new kimono.

"Mioshi," called her mother. "It is time to look at the dolls."

Mioshi was excited. She stood in front of the big family chest. This was where the festival dolls were kept. She had not seen them since last year.

"You may take them out very carefully," said her mother. "I will help Papa put up the shelves."

Mioshi unwrapped the first doll. How beautiful it was! This was the empress doll. It was dressed in beautiful silk clothes. Next would be the emperor doll. Mioshi knew that these two dolls would be on the top shelf. All the others would be on the low shelves.

"Be careful, Mioshi," said her father. "These dolls are very, very old. We must take care of them."

"How old are they?" Mioshi asked.

"Many years," he answered. "They were made long before your grandfather was a little boy. Every family has very old dolls for this festival."

"Can we put them on the shelves now?" she asked.

"No," her father said. "We must wait until the Festival of Dolls begins."

"That will be in two days," said Mioshi. "Then all our friends will come for tea. And they will look at our beautiful dolls!"

"I'm so glad that the Festival of Dolls lasts for three days!" she said. "So many nice things happen that one day wouldn't be enough!"

THE FESTIVAL OF DOLLS

by Thelma Weeks

The Festival of Dolls is a very special time for all the girls of Japan. It's the time of year when they celebrate their birthdays. It's not their real birthday, of course, but no matter when a girl is born, her birthday is celebrated at the time of the Festival of Dolls.

The Festival lasts for three days, and it is one of the nicest times of the year. There are many parties. Girls get new kimonos to wear, and best of all, they get to look at the festival dolls.

Most Japanese families have very old dolls which they keep put away all year in a chest or some special place. Many of the dolls have belonged to a girl's grandmother, great grandmother, or great, great grandmother. The dolls are treasured for they are very valuable. They are dressed elegantly as emperors, empresses, and their clothes are of finest silk.

For the three days of the Festival each family carefully places its festival dolls on tables or open shelves in their home. When guests come for a party or for tea, they pause in front of each doll and "Ooh" and "Ah" over it.

Every Japanese girl looks forward each year to seeing the dolls that belong to her own family and to her friends' families during the Doll Festival. Japanese girls love to have their birthdays all at the same time and to celebrate them with the Festival of Dolls.

The same questions, sometimes worded slightly differently, were used for each literary form. Example:

1. During the Festival of Dolls, all the girls in Japan would
 - a. make silk clothes for dolls.
 - b. put their dolls away in chests.
 - c. celebrate their birthdays.

2. The festival dolls were
 - a. very old and beautiful.
 - b. new every year.
 - c. broken and old.
3. During the festival, people would
 - a. play with dolls.
 - b. give parties for their friends.
 - c. dress in old clothes.
4. The Festival of Dolls lasts
 - a. for a month.
 - b. for three days.
 - c. for one day.

This approach to listening to stories represents in our mind only a beginning in understanding children's reaction to literature. After extensive review of appropriate research findings in readability (Chall, 1958), it was the judged opinion of the staff that this general approach to stories should be followed in order to gain precise information about the role of literature in reference to the population of children with whom we are working. Consequently, we have taken a broader view of story material in the hope that at the end of the year we will formulate a more specific set of hypotheses.

Stories the Children Read

When the children have mastered a sufficient amount of vocabulary, including function and syntax words, stories which are actually read by the children are introduced into the reading lessons. These original children's stories are developed by staff members who are skilled writers and understand children's literature. The principal problem encountered in this process is that of creating stories around a highly restricted vocabulary. Therefore the following criteria were utilized in preparing and editing these original stories:

- 1) the variety of literary themes,
- 2) the children's familiarity with the thematic content and characters,
- 3) logical sequence of events,
- 4) simplicity of plot and characterization, and

- 5) appropriateness in the use of the restricted vocabulary and
- 6) story length.

These stories are first inserted in the lessons at Level III. The list of story titles can be found in Appendix I.

The stories are presented on the scope in the same manner as a story is presented in a story book. The child is to read the story by himself. If he does not know a word, he is directed to touch the word and it is pronounced for him. In fact, the entire sentence in which the touched word appears is read to him. Illustrations are used with the stories as they are needed at certain points to help develop an understanding of the concepts being presented. These illustrations were specified by the authors and prepared by the Project's art staff. Obviously the number of illustrations varies from story to story and an appropriate analysis will be made concerning the influence of these illustrations.

The following is an example of one of these stories:

Swimming
by Thelma Weeks

A chick named Chip sat in his shell.

"Can I chip it?" he said. He picked and he pecked and he chipped at the shell.

"I did it!" he clacked. "I'm not wrapped in my shell! This is swell!"

Chip was so glad not to be in his shell that he grinned.

He pit-a-patted to a lake where some bass were swimming. The bass were flipping and flapping in the lake.

"That would be swell!" he chattered. "I'll take a dip. I'll swim a bit. I'll bet I'll be the most!"

He ran to the lake, but slipped on a stick, and bam! He lit in a tin can.

The tin can slipped and slapped and splattered till it lit in the lake with a clap.

The lake lapped at the tin can and whipped it across the waves.

"So this is swimming! It's swell!" Chip bragged, "I'm the most!"

I'm a winner! I'll swim and swim some more! I'm the bravest and the wettest. The wettest chick of all!"

After the child has completed the story, he is presented with a series of questions to determine his level of comprehension. The types of questions are divided into four main categories:

- 1) questions that deal with the direct recall of facts such as the identification of characters and the sequence of events,
- 2) generalizations about main ideas which relate both characters and events within the story in which these characters and/or events are not presented in close contiguity,
- 3) inferential questions which require the child to relate information presented in the story to information stored in his memory about his own experience, and
- 4) subjective questions which include personal ratings and opinions of the stories.

The given nature and kinds of questions asked about each story are determined by its content, therefore not all stories have exactly the same type of questions. Question types are carefully sequenced throughout the stories to provide equal representation. The number of questions asked about each story varies from four to eight with generally six questions used. Again the questions and the related stories represented an attempt by the Project staff to collect appropriate information which will help us in formulating hypotheses about reading comprehension. Any theoretical development in this area must of necessity relate both the child's immediate information gathering ability and his ability to logically relate this new information with concepts stored in his memory system.

Review Lessons

Two types of review are to be found in the reading lessons. A continuous review is inherent in the learning materials which are sequentially introduced in a given lesson and subsequently incorporated in the activities of succeeding lessons. For example, words which are introduced in list and matrix exercises in lesson N are reviewed in the sentence initiator and story materials of lesson N + 1. A more conventional type of review is

also furnished by lesson designated as review lessons. These appear in approximately every seventh lesson and have no new vocabulary. Vocabulary and concepts previously introduced are re-presented but in different formats.

The nature of the review lessons varies as the vocabulary and skills of the student progressively develop. In Level I the review lessons consist primarily of straight-forward matrix review; that is, the words which have been introduced in the preceding five to seven matrices are reordered and presented in new matrix formats. The review lessons of Level III focus primarily on the recently acquired vocabulary items, prepositioned, and the inflectional concepts of the plural-s, third person singular-s and the -ing suffix.

In Level III the range of activities in the review lessons is considerably increased and basically furnishes the format for review lessons in the succeeding levels. Exercises on phonetic discrimination, word meaning, form class, English word order, rhyming exercises, analysis and synthesis of words, picture-sentence comprehension, compound and polysyllabic words, and verb forms are included. The following is a more detailed description of these materials.

Phonetic Discrimination. A list of three words that differ in only one sound element, (i.e., initial consonant, vowel or final consonant), is presented on the CRT. The student is requested to identify, in a random order, the words on the CRT by means of a touching response (e.g., bat, bet, bit are presented and the student is directed to "Touch and say the following: 1) bet, 2) bat, 3) bit"). This exercise provides review of the letter to sound correspondence presented in the lesson material.

Word Meaning. A review word is used in two sentences and the student is asked if the word has the same or different meanings in the two contexts. As an example, the following sentences would appear on the CRT: "The can is made of tin. The man can make a table." The student is requested to touch the symbol for same if the meanings of can are synonymous, or to touch the symbol for different if the meanings of can are different in the two sentences. This exercise provides a semantic review of the vocabulary as well as the opportunity to read sentences.

Form Class. A sentence is presented on the CRT with one word underlined. Three columns of words are also presented. The columns of words represent the three main form classes of noun, verb, and modifier. The student is required to choose the column of words which can be substituted for the underlined word in the sentence. The exercise appears as follows on the CRT:

<u>CRT</u>		
The car is red.		
<u>1</u>	<u>2</u>	<u>3</u>
hat	black	have
mat	tan	go
hole	last	tan

Audio:
Touch and read the column of words that could take the place of red in the sentence.

This presentation provides a review of the form class features of the vocabulary.

English Word Order. Three strings of words are presented on the CRT. The student is directed to choose the string of words that makes sense. For example, the following strings of words are presented on the CRT:

- | | |
|----|-----------------------|
| 1) | The ran the home man. |
| 2) | The ran man home. |
| 3) | The man ran home. |

Only one of the sentences is grammatically correct and meaningful.

Exercises on English word order are also presented at the phrase structure level. A part of a sentence is presented on the scope and three choices are given for the phrase which would complete the sentence. For example, "Tom ran _____. "

game the to.
to the game.
the game to.

All of this material provides a direct comparison of grammatically correct and incorrect word order.

Rhyming Exercises. Three rhyming words are presented on the scope followed by a sentence where there is a choice of three words for the final word. Two items in the set of choices rhyme with the preceding three words,

and the third word does not rhyme. Only one of the rhyming words in the choice set, however, is meaningful in the sentence. The student is required to choose the word that makes sense in the sentence and rhymes with the three rhyming words. For example:

fate, hate, pate				
Look at the calendar and tell me the	<table border="1"> <tr><td>date</td></tr> <tr><td>late</td></tr> <tr><td>name</td></tr> </table>	date	late	name
date				
late				
name				

This is a composite review activity that focuses on letter to sound correspondences, rhyming, sentence reading and comprehension.

Picture-Sentence Comprehension. A picture is presented on the projector as three sentences appear on the CRT. The student is requested to touch and read the sentence that tells about the picture.

Projector

Picture of a boy with a ship.

CRT

Tim has a ship. Dad has a ship. Tim has a whip.

Audio:

Look at the picture. Read the three sentences. Touch and read the sentence that tells about the picture.

This type of review is parallel to many of the test items in conventional reading tests.

Analysis and Synthesis. A word and a multiple choice set of three letters is presented on the CRT. The student is requested to touch the letter that must be added or deleted from the given word to make a new word. Example:

CRT

	e
mad	o
	a

Audio:

Touch the letter that must be added to mad to make the word made.

	e
made	i
	a

Touch the letter that must be taken away from made to make the word mad.

This is a direct manifestation of letter to sound correspondences and

evaluates the students' comprehension of them.

Compound Words. The first or last syllable of a compound or polysyllabic word is presented on the CRT accompanied by a multiple choice set of three items. The student is requested to touch and say the item that could be put with the first part to make a longer word:

CRT		
		man
mail	_____	rag
		ran

Audio:

Touch and say the word that could be added to mail to make a new longer word.

This provides review for presented words and introduces new combinations of words.

Verb Forms. A sentence in which there is a multiple choice set of three forms of the verb is presented on the scope. The student is requested to read the sentence and touch the word that belongs in the sentence.

Example:

CRT		
Dan	runs running run	to the store.

Audio:

Touch and say the word that makes sense in the sentence.

This exercise provides practice and an evaluation of the students' comprehension of verb inflections.

In Level IV exercises involving synonyms and antonyms are added to the review lessons. A pair of words is presented on the CRT (e.g., fat - thin) and the student is requested to touch the symbol for same if the words mean approximately the same thing, and the symbol for different if the words have opposite meanings. Further additions on the review lessons in Level IV concern the use of polysyllabic words which are reviewed in rhyming and sentence completion exercises.

In addition to the sections described above, each review lesson includes a poem, a game, and a story for independent reading. No single review lesson will include all of the sections which have been described, but will contain some mixture of them. The following outline of a review lesson from Level III' will serve as an illustration.

III' Lesson 21 (Review)

Initial Consonant Discrimination (12 items)

Vowel Discrimination (12 items)

Final Unit Discrimination (12 items)

Rhyming Exercises (10 items)

Poem

English Word Order (sentence completion, 5 items)

Form Class (5 items)

Compound Words (10 items)

Game

Same-Different Word Meaning (10 items)

<-er> (one who does) (10 items)

Sentence Initiators

Story (independent reading)

As stated, the review lessons are intended to provide additional practice for the children, and to provide information to the staff as to the developing abilities of the children.

The Stanford CAI System

The Stanford CAI System is designed to present instructional materials to 16 students simultaneously, with the possibility that each student may work on a completely different set of materials. The reading curriculum that was earlier described is organized so that each child can progress at his own pace branching along a pathway of materials that reflect his particular competencies. It is to be emphasized that every aspect of the instructional sequence is previously specified in minute detail. Every visual display and auditory message that the student might receive, a reply to every response he might conceivably give, a decision procedure for utilizing past performance to determine materials to be presented next, and a coding scheme for storing information on the student's data record must all be planned and prepared in advance. Further more, when an instructional session is finished, a complete record of the sequence of materials presented to the child and his history of responses is available.

The Stanford CAI System consists of a central process computer (Figure 3) (IBM 1500) and accompanying tape-storage units, disk-storage units, card reader/punch, line printer, two proctor stations, and an interphase to 16 student terminals. The central process computer acts as an intermediary between each student and his particular course material which is stored in one of the disk-storage units. A student terminal consists of the following devices:

- 1) a picture projector,
- 2) a cathode ray tube--CRT,
- 3) a light-pen associated with the CRT,
- 4) a modified typewriter keyboard, and
- 5) an audio system which can play pre-recorded messages.

Visual material may be presented to the child on both the CRT and on the film projector. The CRT can display alphabetic or numeric symbols on a 7" x 9" screen with 16 lines and 40 spaces per line. A limited number of prepared line drawings (pictorial patterns) may also be displayed on the CRT. Provision has been made for superscript and subscript positioning of all characters. To gain the attention of the student,

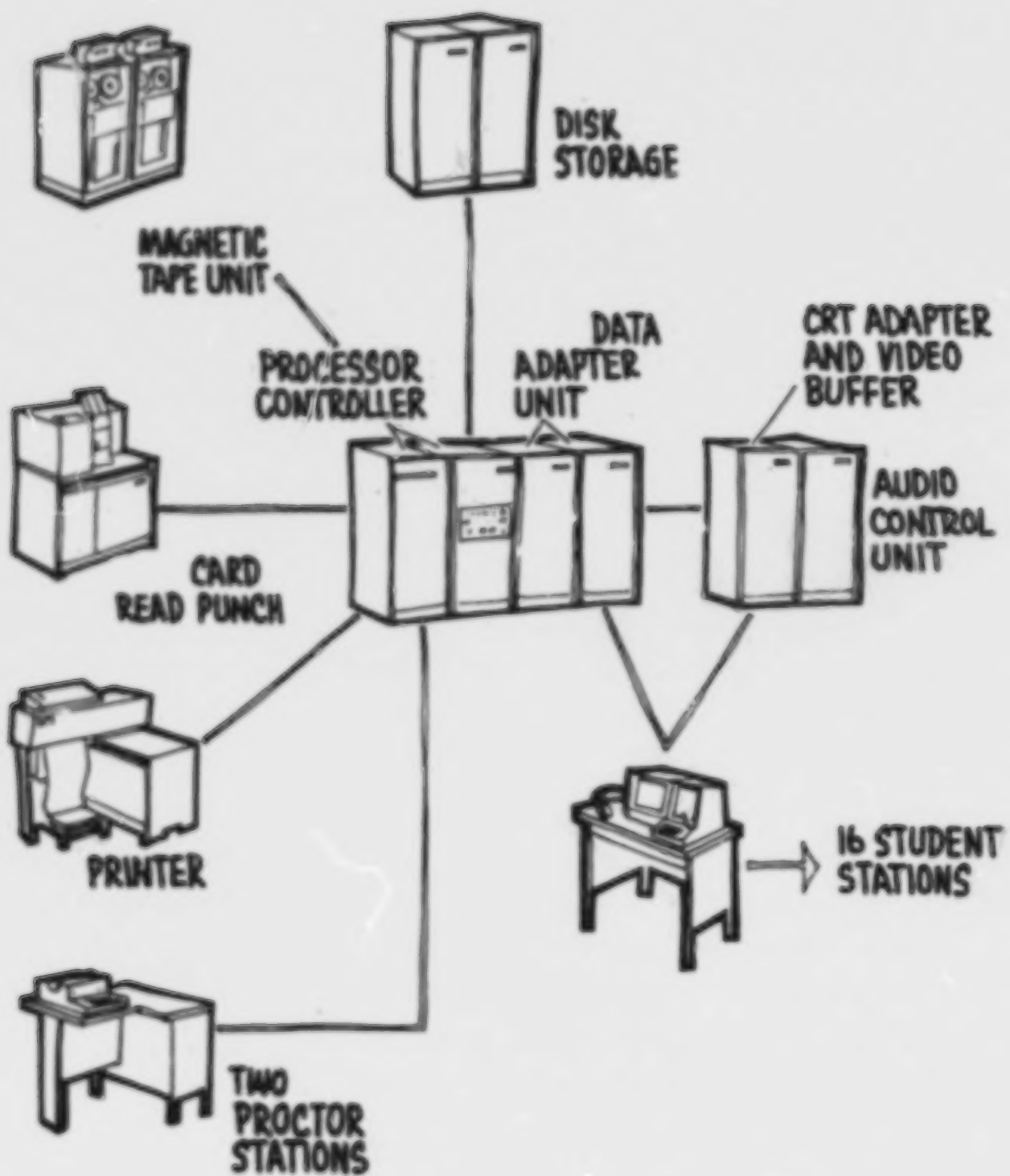


Figure 3. System Configuration for Computer-Assisted Instruction

an emphasis indicator can be placed at any point on the CRT screen to highlight selected items. The indicator may also move along the screen in synchronization with an audio message to emphasize given words or phrases, much like the "bouncing ball" in a singing cartoon.

The pictorial projector is a random-access 16 mm. film device that presents a still image on a 7" x 9" screen. The projected image may be in color or in black and white. The film images are stored in a cartridge with a capacity of 1024 pictures, any one of which can be randomly selected. The time required to change a film cartridge is less than one minute.

The student receives audio messages via a random-access control device capable of selecting any message varying in length from one second to 15 minutes. The audio messages are stored in tape cartridges which contain approximately two hours of messages, and like the film cartridge, may be changed very quickly.

The child can respond to the auditory and visual displays via three input modes: a hand-held light-pen, a typewriter keyset, or a microphone recorder. The student uses the light-pen by touching any point on the CRT screen. While the student is placing the pen, an automatically generated brightening of the area on the display aids him in determining the exact location of the end of the light-pen. Coordinates of the location touched by the light-pen are sensed as a response and recorded by the computer.

Each student terminal is also equipped with a keyboard. When the computer activates the keyboard, the student may enter his responses by striking the desired keys and (depending on the problem) may or may not see the characters displayed on the CRT. If desired, a cursor may be used to indicate the screen position of the next character to be displayed to the child.

The third input mode allows the student to use a microphone to make voice recordings that are stored on the audio tape and can be played back at any later time as determined by the particular instructional program. These student recordings may be saved in a manner similar to any tape recording for off-line data analysis.

When the sequence of instructional events requires a student response, a "ready" light comes on to indicate to the student that the system expects and is prepared for a response entry. The light is turned off when the response has been completed.

The CAI system controls the flow of information and the input of student responses according to the instructional logic built into the curriculum materials. The sequence of events is roughly as follows: the computer assembles the necessary commands for a given instructional sequence or problem from a disk-storage unit. These commands involve directions to the terminal devices to display a sequence of alpha-numeric symbols and specified pictorial symbols on the CRT, to present a given image on the projector, and to play a particular audio message. After the appropriate visual and auditory material has been presented, a "ready" light indicates to the student that a response is expected. Once a response has been entered, it is evaluated by the computer and (on the basis of this evaluation and the student's past history) the computer makes a decision as to what material will subsequently be presented. The time-sharing nature of the system allows for a cycle through these evaluation steps in less than one second.

As each response is input into the system, it is recorded in a concise form that identifies the student, the particular problem he is working on, the response made, and the response time. Thus, a complete history is available for each student which can be used in real time to make decisions regarding the instructional sequence, and for later evaluations.

Lesson Preparation and Data Recording

There are a number of special problems that arise in the computer programming required to present a reading lesson. To give the reader some feeling for these problems we will now consider a simple example in some detail. The example is from the word list section of our lessons and is designed to teach the beginning reader the association between a picture, the word represented, and its correct pronunciation. A

picture illustrating the word being taught is presented on the projector screen. Three words, including the word illustrated, are presented on the CRT screen. An audio message is played asking the child to touch the word on the CRT that matches the picture on the film projector. The student can then make his response using the light-pen. If he makes no response within the specified time limit of 30 seconds, he is told the correct answer, an arrow points to it, and he is asked to touch it. If he makes a response within the time limit, the point that he touches is compared with the correct answer area by the computer. If it is within the correct area he is told that he was correct and he proceeds to the next problem. If the response was not in the correct answer area, it is compared with the area of the defined wrong answers (in this example, the other two words). If his response is in the incorrect area he is told it is wrong, given the correct answer, and asked to touch it. If his initial response was not in the anticipated wrong answer area or in the correct answer area, then the student has made an undefined answer (i.e., has touched a part of the screen with nothing on it). He is given the same message that he would have heard had he touched a defined wrong answer; however, his response is recorded on the data record as undefined.

To prepare an instructional sequence of this sort the lesson programmer must write a detailed list of commands for the computer. He must also record an audio tape of all the messages that the student might hear during the lesson. Each audio message has an address on the tape and may be called for and played when appropriate (not necessarily in sequential order). Similarly, a film strip is prepared with one frame for each picture required in the lesson. Each frame has an address and pictures can be called for in any order desired.

Table 3 shows the audio messages and film pictures required for our example problems along with possible addresses on the audio tape and film strip. The following are the computer commands required to present two examples of the reading problem described above, the processing of the student's responses, and the recording of his responses. The left

Table 3

Audio Script and Film Frames with Hypothetical Addresses

Audio Information

Address	Message
A01:	Touch and say the word that goes with the picture.
A02:	Good. Bag. Do the next one.
A03:	No.
A04:	The word that goes with the picture is bag. Touch and say bag.
A05:	Good. Card. Do the next one.
A06 :	No.
A07 :	The word that goes with the picture is card. Touch and say card.

Film Strip

Address	Picture
F01:	Picture of a bag.
F02:	Picture of a card.

DT 9,18/rat/	Displays "rat" on line 9 starting in column 18 on the CRT.
AUP A01	<u>Audio Play</u> : Plays audio message #A01 "Touch and say the word that goes with the picture."
L1 EP 30/ABCD1	<u>Enter and Process</u> : Activates the light-pen; specifies the time limit (30 seconds) and the problem identifier (ABCD1) that will be placed in the data record along with all responses to this problem. If a response is made within the time limit, the computer skips from this command down to the CA (correct answer comparison) command. If no response is made within the time limit, the commands immediately following the EP command are executed.
AD 1/C4	<u>Add</u> : Adds 1 to the overtime counter (C4).
LD 1/S1	<u>Load</u> : Loads 1 into the error switch (S1).
AUP A04	<u>Audio Play</u> : Plays message #A04 "The word that goes with the picture is bag. Touch and say bag."
DT 7,16/→/	<u>Display Text</u> : Displays "→" on line 7, column 16 (cursor pointing at "bag").
BR L1	<u>Branch</u> : Branches to command labeled L1. The computer will now do that command (EP) and continue from that point.
CA 1,7,3,18/C1	<u>Correct Answer</u> : Compares student's response with the area 1 line high, starting on line 7, 3 columns wide starting in column 18 on the CRT. If his response falls within this area, it will be recorded in the data with the answer identifier C1. When a correct answer has been made, the commands from here down to WA (wrong answer comparison) are executed. Then the machine jumps ahead to the next PR. If the response does not fall in the correct area the machine skips from this command down to the WA command.
BR L2/S1/1	<u>Branch</u> : Branches to command labeled L2 if the error switch (S1) is equal to 1.

AD 1/C1	<u>Add</u> : Adds 1 to the initial correct answer counter (C1).
L2 AUP A02	<u>Audio Play</u> : Plays audio message #A02. "Good. Bag. Do the next one."
WA 1,5,3,18/W1	<u>Wrong Answer</u> : These two commands compare the student's response with the areas of the two wrong answers, that is the area 1 line high starting on line 5, 3 columns wide starting in column 18, and the area 1 line high, starting on line 9, 3 columns wide starting in column 18. If the response falls within one of these two areas, it will be recorded with the appropriate identifier (W1 or W2). When a defined wrong answer has been made, the commands from here down to UN (undefined answer) are executed. Then the computer goes back to the EP for this problem. If the response does not fall in one of the defined wrong answer areas, the machine skips from this command down to the UN command. (The UN command is an undefined answer area response.)
WA 1,9,3,18/W2	
AD 1/C2	<u>Add</u> : Adds 1 to the defined wrong answer counter (C2).
L3 LD 1/S1	<u>Load</u> : Loads 1 into the error switch (S1).
AUP A03	<u>Audio Play</u> : Plays message #A03 "No."
AUP A04	<u>Audio Play</u> : Plays message #A04, "The word that goes with the picture is 'bag.' Touch and say 'bag'."
DT 7, 16/→/	<u>Display Text</u> : Displays "→" on line 7, column 16.
UN	<u>Undefined Wrong Answer</u> : If machine reaches this point in the program the student has made neither a correct nor a defined wrong answer. He must have touched a part of the screen with nothing on it.
AD 1/C3	<u>Add</u> : Adds 1 to the undefined answer counter (C3).
BR L3	<u>Branches</u> : Branches to the command labeled L3. (We want to do the same thing to the student for both UN and WA answers. This branch saves repeating the commands from L3 down to UN.)

PR	Prepares the machine for the second problem.
LD 0/S1	These commands prepare the display for the second problem.
FP F02	Notice the new film position and new words displayed.
DT 5,18/card/	The student was told to "do the next one" when he finished the last problem so he needs no audio message to begin this one.
DT 7,18/cart/	
DT 9,18/hard/	
L4 EP 30/ABCD2	Light-pen is activated.
AD 1/C4	These commands are done only if no response is made in the time limit of 30 seconds, otherwise the machine skips to the CA command.
LD 1/X1	
AUP A07	
DT 5, 16/->/	
BR L4	
CA 1,5,4,18/C2	Compares response with correct answer area.
BR L5/S1/1	1 is added to the initial correct answer counter unless the error switch (S1) shows that an error has been made for this problem. The student is told he is correct and goes on to the next problem. These commands are executed only if a correct answer has been made
AD 1/C1	
L5 AUP A05	
WA 1,7,4,18/W3	Compares response with defined wrong answer.
WA 1,9,4,18/W4	
AD 1/C2	1 is added to the defined wrong answer area and the error switch (S1) is loaded with 1 to show that an error has been made on this problem. The student is told he is wrong and is shown the correct answer and asked to touch it. These commands are executed only if a defined wrong answer has been made.
L6 LD 1/S1	
AUP A06	
AUP A07	
DT 5,16/->/	
UN	An undefined response has been made if the machine reaches this command.
AD 1/C3	1 is added to the undefined answer counter and we branch to give the same audio, etc. as is given for the defined wrong answer.
BR L6	

Thirty counters that can be used to keep track of a student's

performance are available to the lesson programmer. During the instructional flow the current values of these counters are used to make branching decisions regarding the order of the succeeding stimulus materials. For example, if the correct answer counter for a particular class of problems has a high value, the student may be branched ahead to more difficult topics, whereas for a low value he may be branched to remedial work. These counters can contain any number from 0 to 32,767. They are normally set at zero at the beginning of a course and added to depending on the nature of the responses. For example, we use counter 4 (C4) to record overtimes; each time the time limit was exceeded we add one to counter 4 (AD 1/C4).

column lists actual commands to the computer controlling the instruction, Labels L1, L2, etc., in the column on the far left indicate points to which the program can branch. On the right in an explanation of the results of the execution of these commands. The first problem is explained command by command; the second problem is explained only in outline.

<u>Commands</u>	<u>Explanation</u>
PR	<u>Problem</u> : Prepares machine for beginning of new problem.
LD 0/S1	<u>Load</u> : Loads 0 into the error switch (S1). The role of switches and counters will be explained.
FP F01	<u>Film Position</u> : Displays frame F01 (picture of a bag).
DT 5,18/bat/	<u>Display Text</u> : Displays "bat" on line 5 starting in column 18 on the CRT.
DT 7,18/bag/	Displays "bag" on line 7 starting in column 18 on the CRT.

The CAI system also has 32 logic switches which aid in the instructional decision making process. A switch is either in the 0 or 1 position. These are used to keep track of previous events. For example, at the beginning of a problem we load 0 into S1 (our "error" switch). This informs us that no error has yet been made on this problem. If the student makes an error on the problem, we load 1 into S1. Then if a correct answer is made on his second try, we can branch around the command adding 1 to the initial correct answer counter because the error switch (S1) is equal to 1.

There are many features of the CAI system that are not demonstrated by the example we have presented here. The pattern of the problems in the reading materials may vary widely from our example. At various points in a lesson, criteria may be set, which if not met, may cause the student to branch to remedial problems or call the proctor (an available teacher who can assist individual children in need of help). Parts of the CRT display may be underlined or displayed in synchronization with the audio messages.

Frequently used strings of commands may be defined once as a "macro" command and used later by giving a one-line macro command. This cuts down greatly the effort required to present many different but basically similar problems. In fact, a large part of the reading curriculum can be programmed using 200 basic macros.

One should note that a full account of all incorrect and correct answers can be gathered in the array of history registers, although this account is only one portion of the current history of a student. There are a sufficient number of these numerical registers so that any sophisticated scheme of optimization and accompanying branching will be possible. Thus, one would be in a position to present a series of words and to optimize the number of correct responses to some stipulated criteria figure, for example, five consecutive correct responses for each of the words. Or one could select from an array of phrases choosing those phrases for presentation that have the greatest number of errors for any particular learner. From these decisions, each individual student can pursue fundamentally different pathways through the reading materials. The full extent of the flexibility of this decision making capability of the CAI system is still being explored by the Project staff.

Preparation of CAI Reading Materials

This section will cover the functional roles performed by the members of the Project who were involved in the total preparation of the reading lessons. One can fully realize the magnitude of the work undertaken by the staff at Stanford, if one compares it to the preparation of a conventional basal reader series that is specially constructed to clearly manifest certain hypotheses about reading behaviors and their acquisition and retention. The work also involved the preparation of a complete audio script, a necessary part of any CAI reading materials. This preparation of the audio messages to accompany the visual material has been by far the more time consuming and difficult task both to undertake and complete.

In addition to these two tasks, the Stanford Project has had to code (as illustrated in the prior section on computers) the lesson materials with appropriate computer operation codes, so that the system will function

reliably. In order to complete the preparation of materials within the year and a half that we were allowed prior to the delivery of the computer system, a strategy of role differentiation was developed within the Project staff. It was also necessary to develop a sequence by which materials were both conceived, written, edited, typed, recorded, illustrated and coded. Allow us to elaborate on the nature of these steps.

The first stage in the preparation of materials consisted of clearly formulating the chosen hypothesis that was to be manifested in a given section of the curriculum. This included the formulation and statement of the goals and objectives for the particular material, as well as their supporting rationale. Both the rationale and objectives had to indicate, with sufficient clarity, that a set of materials was justified. And lastly, the terminology, the visual format, and, most importantly, the overall learning sequence to be followed had to be specified so that one of the Project staff members could assume the responsibility for writing materials in appropriate quantities without inconsistencies or contradictions.

This planning stage was completed by a team of highly differentiated staff members. The staff consisted, first of all, of two psychologists representing the conventional views of learning theory and programmed instruction. A second member, the Project linguist, pointed out the interrelationships of what is known about the English language as well as contributing ideas concerning psycho-linguistic behavior. In addition, a reading specialist provided a thorough background about existing reading materials as they related to the reading hypotheses under consideration. Fourthly, teachers with extensive classroom experience at the primary level contributed their intuition and experience as to how the questions and materials would relate to children with whom they had previously worked. A computer-assisted instruction expert was also included to indicate clearly what could and could not be achieved with the Stanford CAI system. And finally, after a preliminary planning session, a series of consultants were brought into the Project to provide highly valuable criticism. These consultants indicated very major questions which we had overlooked and which are now manifested in the Stanford reading

materials. They made highly significant contributions to the Project's thinking and direction although the material preparation was the full responsibility of the immediate staff members.

After sufficient research had been completed on the intended materials, one staff member was assigned the task of preparing a sample lesson. After its preparation, the panel was reconvened and naturally differences of views rapidly developed. These were resolved by the running of CAI simulation studies with kindergarten children. To the extent that it was possible, we tried to let young children indicate what was in fact the most appropriate terminology to use, or, in fact, the more reasonable sequence to be first studied before we examined the more extensive and serious question of reading optimality.

Once this evidence was available to us and we had interpreted it, the same staff writer with an additional assistant, prepared the reading materials by sections for many lessons. In other words, one author prepared all of the sentence initiator material throughout the many lessons. This in turn was reviewed by his assistant. I should mention in this regard that we computerized our sequenced vocabulary so that the author had the current vocabulary listings for each lesson level available to him. The authors have found this to be an invaluable aid in the preparation of materials, especially for the sentence and story materials.

After the completion of the written material, it went to a production group. This group initially provided an editorial service, looking for obvious language and typographic errors. A more important function of the group was the criticism of the materials as to their relevancy for young children and their appropriateness for style and such related factors. The supervision of the total writing and editing process was provided by one of the staff members. This was considered quite important in terms of keeping some type of a production schedule under way.

After a written copy had received editorial approval, it was passed on to a group of highly qualified secretaries. These individuals typed the materials and provided any additional editorial corrections, checking for any additional errors. These errors were then referred back to the editorial group. It should be mentioned that this process was facilitated

by the use of standardized forms, an example of which is included in Figure 4. Figure 4 represents one of the many forms now in use to simplify the highly complex process of composing, editing, and typing large quantities of reading lessons. The standardized forms permit the addition of those words and sentences that are necessary for the presentation of the specified lesson and yet maintain consistency throughout the set of reading materials. In this manner, multiple copies of the working curriculum materials become available to the complete staff.

At this point the material was sent to three different groups. The first was a group of very talented artists who prepared the illustration plates for the film which accompanies the reading material. A second group prepares the audio messages on a high fidelity audio recorder. These recordings, in turn, were fed into the computer system for more accurate audio composition and addressing. It is worthwhile to note that we have hired professional dramatists who have recorded all of our story material, using both male and female voices of various age levels. We feel that this should provide us with some insight as to whether it is important, in fact, to get a certain amount of variety into the audio media presented to the children.

The most time consuming task was that of coding up the material for the computer. This was handled by a group of individuals who have developed all of the basic macro structures for handling the lesson material as it would be presented to the terminal devices. We should mention that the coders participated extensively in the writing and production phase of the material in that they specified the nature of the macros prior to any extensive amount of writing so that they knew in advance that the written material was codable. Other groups using CAI systems will have to be sensitive to those learning materials that are easy to code for the computer system so that this process does not become a logistic barrier. In most cases we found it easier to change the writing procedure or the sequencing of the material than it was to change the actual coding. Consequently we adjusted the curriculum materials at this point in minor ways in order to accommodate the computer language and CAI system.

After these three groups had prepared the materials, the completed lesson was then checked-out on the CAI system. This final check for any

Figure 4

Audio for Image _____

[MATCH WORD TO PICTURE AND AUDIO]

[First Frame]

RR 1 Look at the picture and the word.

The word is

[Sentence]

Touch and say

CA: Yes,

WA: No, touch and say

↓CA

RR 2 This word is

[Sentence]

Touch and say

CA: Yes,

WA: No, touch and say

↓CA

RR 3 This word is

[Sentence]

Touch and say

CA: Yes,

WA: No, touch and say

↓CA

RR 4 This word is

[Sentence]

Touch and say

CA: Yes,

WA: No, touch and say

↓CA

(Optimize 1 CA for each RR)

[Delete if list continues]

remaining errors was primarily accomplished by having people play the role of learners, and more specifically, that of either a bright learner, an average learner, or a learner who makes mistakes throughout the entire material. When this debugging phase was finished the materials were then ready for presentation to the students.

Figure 5 presents a flow diagram illustrating the preparation cycle performed by the Stanford Reading Group. Figure 6 indicates the actual physical preparation steps for the computer system. It indicates the necessary steps that the material must undergo after the writing phase in order for it to run on the CAI system. In viewing the complexity of both Figures 5 and 6, one can see why the Project staff decided that a series of simulation studies were more appropriate for examining specific terminology and style questions prior to writing a full series of lessons. The Stanford Learning and Instruction Laboratory was utilized whenever possible in these studies. (It is a second CAI system that is available on the campus (described by Suppes, 1965)).

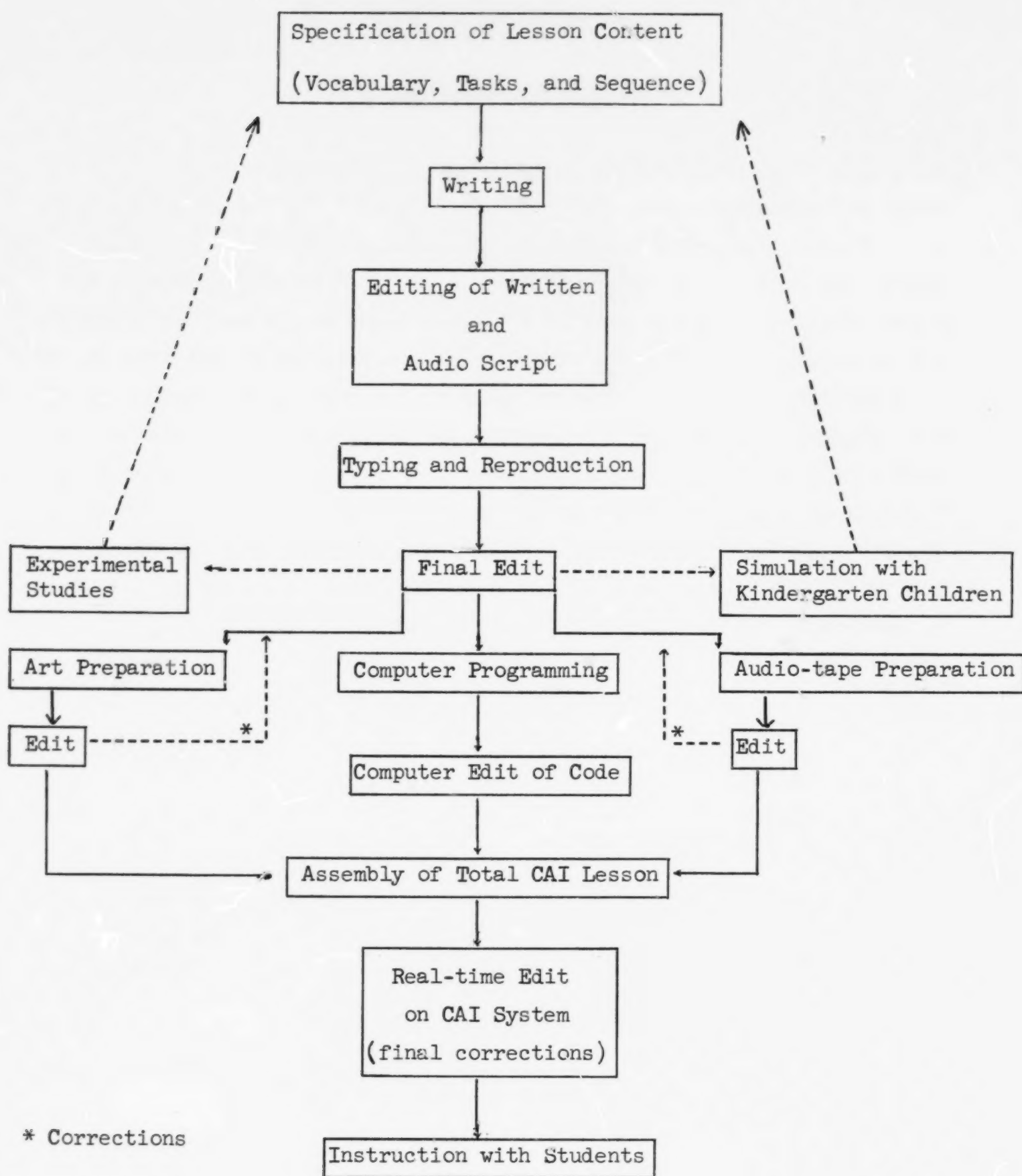


Figure 5

Flow Diagram of Reading Materials Preparation for Stanford CAI Reading System

Stanford-School District Cooperative Plans and Teacher In-Service Training

In the early spring of 1965 the Stanford CAI Project contacted the local school district which was selected for the installation of the CAI system. This meeting consisted of a discussion between two senior Project staff members and the superintendent and the associate superintendent of the school district. Meetings at this level have continued informally on a monthly basis. The purpose of these meetings has been to establish cooperative Stanford-School District policies and to focus on the financial and legal commitments of both groups.

In early June of 1965 a second preliminary meeting took place between a senior staff member from Stanford and a large group of school district staff composed of the central administration, all the elementary school building principals within the district, and the curriculum supervisory staff. A description of the current Stanford CAI efforts was given and precise plans for the establishment of the 1500 CAI system within the elementary school were outlined. This group voted to approve the project. Next, the senior staff member presented the proposed plans to the School District Board of Education. In July of 1965 the Board of Education formally approved an agreement which called for school district-Stanford cooperation for the CAI Project.

During this time an appropriate school was selected for the CAI Project. The criteria for selection were:

- 1) a school with sufficient student population to provide at least 120 and preferably 150 first-grade students who could participate in the project,
- 2) a school whose physical grounds were sufficient to permit the erection of a 30' X 100' building which could become an integral part of the school plan,
- 3) a school whose student population is predominantly composed of "culturally disadvantaged" children, and
- 4) a school whose building principal and faculty have demonstrated through past performance a willingness to undertake new educational innovations.

After the appropriate elementary school had been selected, a tour of the Stanford CAI Laboratory was arranged for the building principal and five of the faculty members. This tour was followed by a two hour conference on the Stanford campus during which the Project was explained to the school staff and tentative plans were established for Stanford-School District interaction, so as to best prepare both groups for this major technological innovation.

With the beginning of the 1965-66 school year a cooperative plan, formulated by the school liaison member representing the Stanford Project and the principal of the elementary school, was arranged whereby one faculty meeting each month was allocated to orienting the total faculty as to the nature of the CAI Project. The focus of this in-service program was based on the need to develop a better understanding of the nature of computer-assisted instruction with its capacities and limitations, of the technology of computers, of the new roles now possible for the classroom teacher, and of the development of new curricular content and pedagogical procedures for a more effective school operation. These presentations were made by the Stanford Project staff.

Seven meetings were held during the fall and winter between the elementary school faculty and the Stanford staff. In addition to the elementary school faculty, the associate superintendent of the district, central office personnel, and visitors were in attendance at the meetings. The seven presentations covering this period were:

- 1) introduction and overview of computer-assisted instruction, the present use of the Stanford CAI Laboratory, tentative plans for the elementary school CAI Project including the new building and new instructional procedures;
- 2) terminology of computer-assisted instruction and programmed instruction, a diagram of the CAI system configuration, and a discussion of its possible use in the current elementary school educational program;
- 3) the nature of programmed instruction, the preparation of objectives, the need for new curricular organization, and its relation to learning theory;

- 4) an overview and critical evaluation of several available programmed texts prepared both commercially and by the school staff;
- 5) the sociology of educational change, the creation of new roles, the function of professional educators, and their interrelation with new technology;
- 6) a series of proposed reading experiments indicating how the CAI system would be utilized for experimentation, and the nature and function of educational experimentation;
- 7) a report to appropriate sub-groups of the experimental results and how they were analyzed and interpreted.

All of these meetings were organized informally so that extensive discussion between the Project staff and the faculty members were both encouraged and pursued in depth.

The Project, in cooperation with San Jose State College Extension Division, offered a two semester unit course in the spring of 1966. This special studies course entitled "Computer-Assisted Instructional Systems, (Educational Innovations)" met 15 times for a two hour period and was instructed by Dr. Duncan Hansen and guest lecturers. The professional educators enrolled included 14 faculty members from the selected elementary school (the principal, and vice-principal, two kindergarten teachers, seven primary grade teachers, and three intermediate grade teachers), 18 other members from the school district (the associate superintendent, two principals, three curriculum consultants, four remedial reading teachers, three primary grade teachers, three intermediate grade teachers, and two junior high school teachers), and five teachers from outside the school district representing three different school systems.

Although the majority of the sessions were led by Dr. Hansen, he was assisted during many of the special meetings by the following Project staff members, Mr. Max Jerman, Mrs. Jamesine Friend, Mr. Hal Wilson, and Mr. Karl Anselm. In addition, the following movies were presented to the group "The Information Machine," "The Computer and the Mind of Man," (series): "The Universal Machine," and "Engine at the Door," "The Computer and Human Behavior," "Passion for Life," and "Informational Retrieval." The course provided the students with an opportunity to do extensive

reading in the area of computer-assisted instruction, programmed instruction, and educational innovation, as well as the opportunity to investigate the problems involved in programming and planning for educational innovations and developing curriculum for CAI.

The following course outline was followed closely:

1. Introduction to CAI.
2. Programmed instruction: Theories of learning, overview of programmed instruction, general concepts.
3. Programmed instruction: Analysis of instructional objectives and subject matter units (Mr. Max Jerman).
4. Programmed instruction: Frame units, stimulus and response structure.
5. Programmed instruction: Frame sequence, program characteristics, program development, and theories of optimal learning.
6. Overview of existing CAI systems.
- *7. CAI languages, overview of IBM COURSEWRITER II, and computer time-sharing.
- *8. Characteristics of CAI language and how CAI material is coded.
9. Research findings in CAI, especially applications in the language arts area, spelling and reading.
10. Research findings in CAI, especially applications in mathematics (Mrs. Jamesine Friend).
11. Research findings of CAI in other curriculum areas, and especially in the areas of achievement testing and applications throughout the school system. (Mr. Hal Wilson).
12. The new role of the teacher in CAI; teacher preparation for new technological innovations in education.
13. Relationships of teacher, supervisor, and curriculum supervisors in CAI innovations. Formal and informal teacher preparation (Mr. Karl Anselm).
14. How a school system works on a project of innovation; (Mr. Karl Anselm)

15. Review and course project evaluations, final examination.

(*These two meetings of the course were designed to meet specific interests of the class membership and they selected the lecture and discussion they wished to attend.)

Instructional techniques consisted of lectures, large and small group discussions, visitations, films, and individualized term projects related to the participants interested and job responsibilities. An evaluation of the activities of the course is being prepared (Karl Anselm, "The Dynamics of Educational Innovation"). This document will cover extensive rating scales, open-ended questionnaires, and individual interviews as well as standardized instruments such as the OCDQ Scale for school climate. The purpose of this evaluation is to discover which portions of the course were most valuable to the teachers in providing the necessary information and conceptual understandings to effectively participate in the new CAI program.

A more highly specific program of in-service activity was initiated for intensive explanation and questioning of the Stanford Project's reading and mathematics curricula. The mathematics curriculum was presented during lunch-time meetings by Mrs. Jamesine Friend to the school principal, and first-grade teachers whose classes are assigned to the mathematics portion of the Project. Dr. Duncan Hansen and Mr. Hal Wilson presented during seven release-time meetings (i.e., during the school day) the reading curriculum to the school principal, the primary grades curriculum consultant, the school guidance counselor, the school-home community worker, and two first-grade teachers whose classes are assigned to the reading portion of the Project. These meetings initiated the intensive interaction between Project staff and school district personnel which will continue this summer with a workshop and into the fall during weekly planning groups.

Future Plans

The major commitment for the coming year is the daily instruction of 120 children in initial reading. A detailed daily schedule and precise operating procedures for this period are being determined jointly by the Project staff and the School District personnel. This cooperative venture has produced tentative operating plans, however the Project is remaining flexible as undoubtedly many unanticipated problems will arise.

Working groups have been organized to assume responsibility in the areas of daily scheduling, daily CAI operations, special learning cases, classroom reading activities, curriculum modifications, data analysis, and experimentation. Consequently, we have added additional staff members to aid in the daily operations including, among others, a qualified child psychologist to study the children who do not adapt to CAI activities or who experience special learning difficulties. The organizational structure and activities of these groups will be discussed in a future report.

The Project staff will continue to prepare and write learning materials. This development will ultimately result in a reading and language arts curriculum for grades one through six. The primary focus, however, will be on experimentation, especially in psycho-linguistic behaviors of reading and learning optimization procedures. We hope that these studies and future research will lay the groundwork for both a theory of reading and a theory of instruction. Such theories will have to be based on a rich and highly structured theory of learning, in addition to an optimization strategy that follows logically from the theories, and is compatible with current educational goals.

APPENDIX A

Matrices and Word Lists

LEVEL I, LESSON 1

fan
man
tan
can
nan
dan

LEVEL I, LESSON 5

		ab	at
nab	d	deb	det
tab	n	nab	nat
cab	c	cab	cat
dab	t	tab	tat

LEVEL I, LESSON 9

		ag	at	an
ran	b	bag	bat	ban
pan	r	rag	rat	ran
bat	p	pag	pat	pan
rat				
pat				
bag				
rag				

LEVEL I, LESSON 2

		at	an
nat	f	fet	fan
bat	m	met	man
cat	s	cet	can
fat	h	hat	han
net			

LEVEL I, LESSON 6

		an	ag
nag	n	nan	nag
tag	t	tan	tag
hag	h	han	hag
sag	s	san	sag

LEVEL I, LESSON 10

		ap	ad	am
ham	m	map	mad	man
Sam	h	hap	had	han
nap	f	fap	fad	fam
fad	s	sap	sad	san
mad				
sad				
had				

LEVEL I, LESSON 3

(Review)		an	at
n		nan	nat
c		cen	cat
t		ten	tat
d		den	det

LEVEL I, LESSON 7

(Review)	ag	at	ab	an
n	nag	nat	nab	nan
m	mag	mat	ma	man
f	fag	fet	fab	fam
s	sag	sat	sab	san

LEVEL I, LESSON 11

Syntax
that
he's
she's
is
have

LEVEL I, LESSON 4

(Review)		an	at
Syntax	d	den	det
I'm	c	cen	cat
it's	f	fen	fet
this	m	men	mat
who's	h	han	hat
what's	s	sen	sat
	t	ten	tat

LEVEL I, LESSON 8

(Review List and Matrix)		ab	an	at	ag
d		deb	den	det	dag
c		cab	cen	cat	cag
t		tab	ten	tat	tag
n		nab	nan	nat	nag

LEVEL I, LESSON 12

		an	ad	ap
d		dan	dad	dap
c		can	cad	cop
n		nan	nad	nep
t		tan	ted	tap

APPENDIX A (continued)

LEVEL I, LESSON 13

		ad	an	ap
pad	p	pad	pam	pap
bad	b	bad	bam	bap
rap	r	rad	ram	rap
ram				
pam				

LEVEL II, LESSON 4

		im	in
tim	t	tim	tin
him	h	him	hin
rim	r	rim	rin
tin			

LEVEL II, LESSON 8

		ab	ag
crag	cr	crab	crag
drag	dr	drab	drag
crab	gr	grab	
grab			
drab			

LEVEL II, LESSON 1

Plural of nouns

LEVEL II, LESSON 5

		im	in
pin	b	bim	bin
din	p	pim	pin
win	d	din	din
hin	w	wim	win
dim			

LEVEL II, LESSON 9

		ad	an	ag
brad	fr	frad	fran	
brag	br	brad	bran	brag
fran				
trap				
bran				

LESSON 9'

ing (of verb)
of
or

LEVEL II, LESSON 2

		ap	ip
sip	t	tap	tip
tip	r	rap	rip
hip	h	hap	hip
rip	s	sap	sip
nip	n	nap	nip

LEVEL II, LESSON 6

on
in
at
to

LEVEL II, LESSON 10

		it	id	ig
hit	r	rit	rid	rig
hid	h	hit	hid	hig
pig	p	pit	pid	pig
rig	b	bit	bid	big
bit				
big				
pit				
bid				
rid				

LEVEL II, LESSON 3

Third person singular
of the verb

LEVEL II, LESSON 7

		ab	ag	an	ap
stab	sn	snab	snag		snap
stan	sp	spab	spag	span	
span	st	stab	stag	stan	stap
snap					
stag					
spat					
snag					

LEVEL II, LESSON 11

		id	it	ig	in
sid	f	fid	fit	fig	fin
fig	s	sid	sit	sig	sin
fin					
sit					
fit					

APPENDIX A (continued)

LEVEL II, LESSON 12

		ip	ig	id	it
dip	d	dip	dig	did	dit
wit	w		wig	wid	wit
lit	l	lip	lig	lid	lit
dig					
did					
wig					
lip					
lid					

LEVEL II, LESSON 16

		ap	an	at
chan	ch	chap	chan	chat
chap	th		than	that
chat	wr	wrap		
than				
that				
wrap				

LEVEL III, LESSON 3

		im	ip
flip	fl	flim	flip
grim	sl	slim	slip
grip	gr	grim	grip
slim	tr	trim	trip
slip			
trim			
trip			
(they're)			

LEVEL II, LESSON 13

		ab	ag	ad	ap
lag	w	wab	wag	wad	wap
lad	l	lab	lag	lad	lap
wag					
lab					
lap					

LEVEL II, LESSON 17,18

(No word lists or matrices)

LEVEL III, LESSON 4

		in	id	it
flit	fl	flin		flit
grid	sl		slid	slit
grin	sp	spin		spit
grit	gr	grin	grid	grit
slid				
slit				
spin				
(we've)				
(you're)				

LEVEL II, LESSON 14

		an	ab	ag	at
clan	cl	clan		clag	clat
flag	fl		flab	flag	flat
flat	pl	plan	plab	plag	plat
plan	sl		slab	slag	slat
slab					
slag					
slat					

LEVEL III, LESSON 1

		en	em
hem	p	pen	pem
hen	m	men	mem
men	h	hen	hem
pen	t	ten	tem
ten			

LEVEL III, LESSON 5

		ed	et	eg
bed	t	ted		
beg	g	ged	get	geg
bet	b	bed	bet	beg
get				
ted				

LEVEL II, LESSON 15

		ap	am	ad
clad	cl	clap	clam	clad
clam	sl	slap	slam	slad
clap	fl	flap	flam	flad
flap	gl	glap	glam	glad
glad				

LEVEL III, LESSON 2

		ed	et
fed	r	red	rèt
met	n	ned	net
ned	s		set
net	f	fed	fet
set	m	med	met

LEVEL III, LESSON 6

		eg	ed	et
led	p	peg	ped	pet
leg	l	leg	led	let
let	w	weg	wed	wet
peg				
pet				
wed				
wet				

APPENDIX A (continued)

LEVEL III, LESSON 7

(Review)

as
has

LEVEL III, LESSON 11

am ame

came	d	dam	dame
dame	g	gam	game
game	s	sam	same
same	t	tam	tame
tame	c	cam	came

(I'll)
(we'll)

LEVEL III, LESSON 15

ad ade

blade	tr	trad	trade
fade	sp	spad	spade
glade	gr	grad	grade
grade	m	mad	made
made	gl	glad	glade
spade	w	wad	wade
trade	bl	blad	blade
wade	f	fad	fade

(plurals, 3rd person singular
with final e words)

LEVEL III, LESSON 8

im ip

brim	wh	whim	whip
prim	pr	prim	
swim	br	brim	
whim	sw	swim	
whip			

LEVEL III, LESSON 12

am ame

blame	bl	blam	blame
fame	fr	fram	frame
flame	l	lam	lame
frame	fl	flam	flame
lame	n	nam	name
name	f	fam	fame

LEVEL III, LESSON 16

at ate

date	n	nat	nate
fate	h	hat	hate
gate	g	gat	gate
hate	f	fat	fate
mate	d	dat	date
nate	m	mat	mate
ate	p	pat	pate

(ing with final e words)

LEVEL III, LESSON 9

ip in

chin	th		thin
chip	ch	chip	chin
clip	dr	drip	
drip	sh	ship	
ship	cl	clip	
snip	sn	snip	
thin			

LEVEL III, LESSON 13

an ane

cane	p	pan	pane
crane	m	man	mane
dane	c	can	cane
lane	cr	cran	crane
mane	l	lan	lane
pane	d	dan	dane
sane	s	san	sane

LEVEL III, LESSON 17

(x Words)

can't
wasn't
are
don't
can't
didn't

LEVEL III, LESSON 10

Introduction of:
er, est (comparison
of adjectives)

LEVEL III, LESSON 14

(Review)

LEVEL III, LESSON 18

at ate

crate	sl	slat	slate
grate	gr	grat	grate
late	cr	crat	crate
plate	l	lat	late
rate	st	stat	state
slate	r	rat	rate
state	pl	plat	plate

(er, est with final e words)

APPENDIX A (continued)

LEVEL III, LESSON 19

		ap	ape
cape	gr	grap	grape
drape	c	cap	cape
grape	dr	drap	drape
tape	t	tap	tape
ape			

LEVEL III, LESSON 23

Introduction of:
ed (past tense of
verb)
was
were

LEVEL III', LESSON 4

		are	ase
bare	b	bare	base
base	c	care	case
care	d	dare	
case	f	fare	
dare	h	hare	
fare			
hare			

LEVEL III, LESSON 20

		ag	age
cage	st	stag	stage
page	r	rag	rage
rage	g	gag	gage
sage	s	sag	sage
stage	p	pag	page
wage	w	wag	wage
age	c	cag	cage

LEVEL III', LESSON 1

		ake	ave	ale
fake	s	sake	save	sale
sake	f	fake		
sale				
save				
(possessives)				

LEVEL III', LESSON 5

		are	ale
male	p	pare	pale
mare	m	mare	male
pale	w	ware	
pare	r	rare	
rare			
ware			

LEVEL III, LESSON 21

(Review)

LEVEL III', LESSON 2

		ave	ake
bake	c	cave	cake
cake	t	tave	take
cave	b	bave	bake
dave	p	pave	
gave	g	gave	
pave	d	dave	
take			

LEVEL III', LESSON 6

		ake	ave
brake	gr	grake	grave
brave	sl	slake	slave
flake	br	brake	brave
grave	fl	flake	
slave	sn	snake	
snake			

LEVEL III, LESSON 22

Introduction of:
er (one who does)

LEVEL III', LESSON 3

		ake	ave
lake	r	rake	rave
make	w	wake	wave
rake	m	make	
rave	l	lake	
wake			
wave			

LEVEL III', LESSON 7

(No matrix or word list)

APPENDIX A (continued)

LEVEL III', LESSON 8

		ale	ave	ake
shake	sh	shale	shave	shake
shale	st	stale	stave	stake
shave	wh	whale		
stake				
stale				
stave				
whale				

LEVEL III', LESSON 11

	m	b	
ball	mell	bell	ell
bar	mall	ball	all
bell	mill	bill	ill
bill	mar	bar	ar
mar			
mill			
all			

LEVEL III', LESSON 15

(Review)

LEVEL III', LESSON 9

		ill	ick
dick	n	nill	nick
dill	p	pill	pick
nick	d	dill	dick
pick			
pill			
ill			

LEVEL III', LESSON 12

	t	h	
hall	tar	har	ar
hill	tall	hall	all
tall	till	hill	ill
tar	tell		ell
tell			
till			

LEVEL III', LESSON 16

		ar	ill	eck
char	sp	spar	spill	speck
check	ch	char	chill	check
chill	st	star	still	
spar				
speck				
spill				
star				
still				

LEVEL III', LESSON 10.1

		ick
chick	l	lick
lick	ch	chick
sick	t	tick
tick	s	sick
wick	w	wick

LEVEL III', LESSON 13

	s	f	
fall	sar	far	ar
far	sall	fall	all
fell	sell	fell	ell
fill	sill	fill	ill
sell			
sill			

LEVEL III', LESSON 17

		ix	ir
fir	s	six	sir
fix	f	fix	fir
mix	m	mix	
sir			
six			

LEVEL III', LESSON 10.2

		ick
brick	br	brick
click	cl	click
stick	st	stick
slick	sl	slick
trick	tr	trick
thick	th	thick

LEVEL III', LESSON 14

	w	c	
call	wall	call	all
car	well		ell
wall	will		ill
well	war	car	ar
will			

LEVEL III', LESSON 18

		ack	aw	ass
pack	p	pack	paw	pass
pass	r	rack	raw	
paw	s	sack	saw	
rack				
raw				
sack				
saw				

APPENDIX A (continued)

LEVEL III', LESSON 19

		ack	ax	ass	aw
back	l	lack	lax	lass	law
bass	b	back	bax	bass	
lack	t	tack	tax	tass	
lass					
law					
lax					
tack					
tax					

LEVEL III', LESSON 23

		all	ack
black	tr	trall	track
smack	bl	blall	black
small	sh	shall	shack
stack	st	stall	stack
stall			
track			

LEVEL III', LESSON 27

		ack	ill
frill	wh	whack	frill
drill	sn	snack	drill
grill	sl	slack	grill
slack			
snack			
whack			

LEVEL III', LESSON 20

		eck
deck	p	peck
neck	n	neck
peck	d	deck

LEVEL III', LESSON 24

		ack	aw
clack	fl	flack	flaw
claw	cr	crack	craw
crack	dr	drack	draw
craw	cl	clack	claw
draw	sh	shack	shaw
flaw			
shack			

LEVEL III', LESSON 28

(No word list or matrix)

LEVEL III', LESSON 21

(Review)

LEVEL III', LESSON 25

		ell
shell	sw	swell
smell	sm	smell
spell	sh	shell
swell	sp	spell

LEVEL IV, LESSON 1

		od	ot
nod	n	nod	not
pod	p	pod	pot
pot	r	rod	rot
rod			
rot			
not			

LEVEL III', LESSON 22

		ass
brass	gl	glass
class	gr	grass
glass	cl	class
grass	br	brass

LEVEL III', LESSON 26

		ess
bless	bl	bless
chess	dr	dress
dress	l	less
less	pr	press
press	ch	chess
tress	tr	tress

LEVEL IV, LESSON 2

		ob	od	op
bob	b	bob		bop
bop	c	cob	cod	
cob	h	hob	hod	hop
cod	m	mob		mop
hob				
hod				
hop				
mob				
mop				

APPENDIX A (continued)

LEVEL IV, LESSON 3

		od	ot	ob
sob	s	sod	sot	sob
sod	t	tod	tot	tob
tod			og	
tot				
dog	d	dog		
fog	f	fog		
hog	h	hog		
log	l	log		

LEVEL IV, LESSON 7

		ed
bled	sl	sled
fled	fl	fled
Fred	fr	fred
shed	sh	shed
sled	sp	sped
sped	bl	bled

LEVEL IV, LESSON 11

		ast	act
cast	f	fast	fact
fact	p	past	pact
fast	t		tact
last	c	cast	
mast	l	last	
pact	m	mast	
past			
tact			
act			

LEVEL IV, LESSON 4

		op	om
mom	t	top	tom
mop	m	mop	mom
tom			
top			

LEVEL IV, LESSON 8

		en	em
glen	th	then	them
then	gl	glen	
them	wh	when	
when			
step			
(there's)			

LEVEL IV, LESSON 12

		ask	ath
bask	b	bask	bath
bath	m	mask	math
mask	p		path
math	t	task	
path			
task			
ask			
(I'd)			
(you'd)			

LEVEL IV, LESSON 5

		on	ot
cot	r	ron	rot
don	d	don	dot
dot	g		got
got	c		cot
hot	h		hot
ron	l		lot
rot			
lot			
(for)			
(from)			

LEVEL IV, LESSON 9

		amp	ash
camp	c	camp	cash
cash	d	damp	dash
damp	l	lamp	lash
dash	r	ramp	rash
lamp			
lash			
ramp			
rash			
ash			

LEVEL IV, LESSON 13

		and	ant
band	b	band	pant
hand	h	hand	rant
land	l	land	
pant	s	sand	
sand			
rant			
ant			
want (taught separately)			
wash (taught separately)			

LEVEL IV, LESSON 6

(Review)

LEVEL IV, LESSON 10

(Review)

LEVEL IV, LESSON 14

(Review)

APPENDIX A (continued)

LEVEL IV, LESSON 15

		id	ide
bide	b	bid	bide
bride	r	rid	ride
hide	br	brid	bride
ride	h	hid	hide
side	s	sld	slide
slide	sl	slid	slide

LEVEL IV, LESSON 19

(Review)

LEVEL IV, LESSON 22

(Syntax Words)

who
what
when
where
why

LEVEL IV, LESSON 16

		in	ine
dine	d	din	dine
fine	f	fin	fine
line	m	lin	line
mine	p	pin	pine
pine	sp	spin	spine
shine	sh	shin	shine
spine	l	lin	line

LEVEL IV, LESSON 20

(Syntax Words)

me
she
we
be
he
they

LEVEL IV', LESSON 1

		arn	art
cart	d	darn	dart
bart	c	car	cart
darn	p	par	part
dart	b	barn	bart
part			
art			

LEVEL IV, LESSON 17

		ide
glide	t	tide
pride	w	wide
tide	pr	pride
wide	gl	glide

(wouldn't)

LEVEL IV, LESSON 21.1

		y
by	b	by
my	m	my
try	tr	try
sky	sk	sky
fly	fl	fly
pry	pr	pry

LEVEL IV', LESSON 2

		ark	ard
bark	b	bark	bard
card	c	car	card
dark	p	par	pard
park	d	dark	dard
ark			

LEVEL IV, LESSON 18

		ime	ite
dime	d	dime	bite
chime	t	time	white
lime	l	lime	
chime	ch	chime	
bite			
white			

LEVEL IV, LESSON 21.2

		y
fry	fr	fry
why	wh	why
shy	sh	shy
sly	sl	sly
dry	dr	dry
cry	cr	cry

LEVEL IV', LESSON 3

		art	ark	ard
hard	h	hart	hark	hard
lark	l	lart	lark	lard
mark	m	mart	mark	ward
lark				
mark				
mart				

APPENDIX A (continued)

LEVEL IV', LESSON 4

		ay	ain
day	pl	play	plain
drain	dr	dray	drain
gray	gr	gray	grain
grain	d	day	
gray			
plain			
play			

LEVEL IV', LESSON 8

		ile	ire
file	sp	spile	spire
fire	w		wire
mile	f	file	fire
mire	t	tile	tire
pile	m	mile	mire
spire	p	pile	pire
tile			
tire			
wire			

LEVEL IV', LESSON 12

	tr	br	ain
braid	train	brain	ain
brain	tray	bray	ay
bray		braid	aid
trail	trail	brail	ail
train			
tray			

LEVEL IV', LESSON 5

		ay	ain
chain	pr	pray	
clay	sl	slay	slain
pray	st	stay	stain
slay	cl	clay	
slain	ch		chain
stain			
stay			

LEVEL IV', LESSON 9

		ive	ire	ike
dike	d	dive	dire	dike
dive	l	live	lire	like
five	f	five	fire	fike
hike	h	hive	hire	hike
hire				
hive				
like				
live				
(give)				
(live)				

LEVEL IV', LESSON 13

	g	p	ain
gail	gain	pain	ain
gain	gay	pay	ay
gay	gaid	paid	aid
paid	gail	pail	ail
pail			
pain			
pay			

LEVEL IV', LESSON 6

		ail	ay
sail	s	sail	say
say	t	tail	
snail	sn	snail	
tail			
(said)			

LEVEL IV', LESSON 10

		ike	ile
bike	tr	trike	while
mike	sp	spike	smile
pike	p	pike	
smile	b	bike	
spike	m	mike	
trike			
while			

LEVEL IV', LESSON 14

	n	m	ail
maid	naill	mail	ail
mail		maid	aid
main	nay	may	ay
may		main	ain
naill			
nay			

LEVEL IV', LESSON 7

(Review)

under
down
out
off

LEVEL IV', LESSON 11

	l	r	ail
laid	leil	rail	ail
lain	lein	rain	ain
lay	lay	ray	ay
raid	laid	raid	aid
rail			
rain			
ray			
aid			
ail			

LEVEL IV', LESSON 15

		ay	ail	ait
bail	b	bay	baill	ba'tt
baill	w	vay	vaill	va'tt
bay	h	hay	haill	
day	f	fay	faill	
faill	d	day		
fay				
hay				
haill				
vaill				
wait				
way				

APPENDIX A (continued)

LEVEL IV', LESSON 16

(Review)

LEVEL IV', LESSON 20

		ook	oot
book	b	book	boot
boot	t	took	toot
cook	c	cook	
took			
toot			

LEVEL IV', LESSON 24

		oon	oom
loon	l	loon	loom
loom	r		room
moon	n	moon	
noon	n	noon	
room	s	soon	
soon	sp	spoon	
spoon			

LEVEL IV', LESSON 17

		oss
toss	gl	gloss
gloss	m	moss
loss	t	toss
moss	l	loss
ross	b	boss
toss	r	ross

LEVEL IV', LESSON 21

		oot	ook
hook	r	root	rook
hoot	l	loot	look
look	sh	shoot	
loot	h	hoot	hook
rook			
root			
shoot			

LEVEL IV', LESSON 25.1

		oom
bloom	bl	bloom
broom	gl	gloom
boom	br	broom
gloom	gr	groom
groom	b	boom

LEVEL IV', LESSON 18

		oll	ox
box	r	roll	b box
fox	tr	troll	f fox
roll	t	toll	
toll			
troll			
ox			
(doll)			

LEVEL IV', LESSON 22

		ook
brook	tr	brook
crook	cr	crook
nook	sh	shook
shook	h	hook

LEVEL IV', LESSON 25.2

(No Matrix)	
Jan	Jade
Jen	Jill
Jim	Jer
Jed	Jaw
Jane	Jack
Job	

LEVEL IV', LESSON 19

		alt	arm
fern	h	halt	harm
halt	f		farm
harm	s	salt	
malt	v	walt	
salt	m	malt	
walt			
arm			
warn (taught separately)			
warm (taught separately)			

LEVEL IV', LESSON 23

(Review)

LEVEL IV', LESSON 26

		ood
good	v	wood
hood	st	stood
stood	h	hood
wood	g	good
(foot)		
(wool)		

APPENDIX A (continued)

LEVEL IV', LESSON 27

		ool
cool	t	tool
fool	e	rool
pool	p	pool
spool	r	fool
stool	op	spool
tool	ot	stool

LEVEL IV', LESSON 30

		ight
fight	n	night
light	e	eight
night	f	flight
right	c	eight
right	i	flight
sight	r	right
tight	t	flight

LEVEL V, LESSON 2

		un	un
gun	h	gun	gun
run	g	gun	gun
run	b	gun	gun
run	f	gun	gun
run	r	gun	gun
gun	s	gun	gun
gun			
gun			

LEVEL IV', LESSON 28

		ock
cock	t	tock
dock	d	tock
lock	e	tock
rock	o	tock
sock	i	tock
tock	r	tock

LEVEL IV', LESSON 31

		ight
blight	el	alight
bright	fl	flight
flight	tr	bright
alight	fr	flight
fright	bl	blight

LEVEL V, LESSON 3

		ug	ub
rub	r	rug	rub
tug	h	tug	tub
rub	e		rub
tug	t	tug	tub
tub			
tug			
tub			

LEVEL IV', LESSON 29.1

		ock
block	sh	stock
clock	cl	stock
flock	et	stock
snock	em	stock
stock	fl	flock
stock	bl	block

LEVEL IV', LESSON 32

(Review)

LEVEL V, LESSON 4

		up	ut
but	n		but
nut	c	nut	nut
put	p	put	
but	n	put	but
put			
(put)			
(but)			

LEVEL IV', LESSON 29.2

(No Matrix)

kin	van
kit	vane
ken	vase
kick	vine
kite	
key	

LEVEL V, LESSON 1

		ud	ug
dug	b	bud	bug
bug	d	bud	bug
bud	n	bud	bug
Jud	j	bud	bug
mad	p	bud	bug
jug			
jug			
Jug			

LEVEL V, LESSON 5

		ot	op
chap	er		crop
chap	et		crop
drop	ch		crop
trot	sh	shot	shop
crop	tr	trot	trug
shot	dr		drop
stop			

APPENDIX A (continued)

LEVEL V, LESSON 6

(Review)

LEVEL V, LESSON 10

		ish	ist
wish	l	lish	list
dish	d	dish	dist
fish	m	mish	mist
mist	w	wish	wist
list	f	fish	fist
fist			

LEVEL V, LESSON 14.1

		atch	arch
match	p	patch	perch
latch	l	latch	larch
perch	m	match	march
starch	st		starch
patch			
march			
larch			
(arch)			

LEVEL V, LESSON 7

		ot	op
blot	cl	clot	clop
clop	pl	plot	plop
slot	fl		flop
slop	sl	slot	slop
flop	bl	blot	blot
plop	sp	spot	
plot			
clot			

LEVEL V, LESSON 11

		ilk	ift
sift	r		rift
silk	s		gift
gift	m	silk	sift
rift	l	milk	mift
lift			lift
milk			

LEVEL V, LESSON 14.2

		atch
snatch	sn	snatch
catch	h	hatch
hatch	b	batch
batch	c	catch
(watch)		

LEVEL V, LESSON 8

		od
trod	pr	prod
shod	tr	trod
plod	sh	shod
prod	pl	plod
(frog)		
(snog)		

LEVEL V, LESSON 12

(Review)

LEVEL V, LESSON 15

		amp	est
chest	ch	champ	chest
tramp	cr	cramp	crest
clamp	sc	scamp	
cramp	cl	clamp	
crest	tr	tramp	
scamp	st	stamp	
stamp			
(swamp)			

LEVEL V, LESSON 9

		ilt	int
lint	h	hilt	hint
print	gl		glint
milt	t	tilt	tint
glint	m	milt	mint
tilt	l	lilt	lint
tint	pr		print
mint			
hint			
hilt			

LEVEL V, LESSON 13

		ash	ask
crash	fl	flash	flask
flash	sl	slash	
smash	tr	trash	
flask	sm	smash	
slash	cl	clash	
trash	cr	crash	
clash			

LEVEL V, LESSON 16

		and	ind
blind	gr	grand	grind
stand	bl	bland	blind
grind	gl	glend	
brand	st	stend	
bland	tr	brand	
glend			
grand			

APPENDIX A (continued)

LEVEL V, LESSON 17

		anch	ast
ranch	r	ranch	rast
blast	bl	blanch	blast
blanch	br	branch	
branch			

LEVEL V, LESSON 21

		obe	ope
hope	h	hobe	hope
lope	l	lobe	lope
rope	r	robe	rope
mope	m	mobe	mope
robe			
lobe			

LEVEL V, LESSON 25

		itch	inch
pitch	w	witch	winch
ditch	p	pitch	pinch
pinch	m	mitch	
mitch	d	ditch	
hitch	h	hitch	
winch			
witch			
(inch)			
(itch)			
(birch)			

LEVEL V, LESSON 18

		ude	ote
rote	v		vote
dote	d	dude	dote
vote	n	nude	note
nude	r	rude	rote
note			
dude			
rude			

LEVEL V, LESSON 22

		one
stone	c	cone
cone	b	bone
bone	l	lone
lone	t	tone
shone	sh	shone
tone	st	stone
(one)		
(none)		
(done)		
(gone)		

LEVEL V, LESSON 26

		ink	etch
fetch	k	kink	ketch
kink	r	rink	retch
pink	f		fetch
ketch	p	pink	
mink	m	mink	
rink			
(ink)			

LEVEL V, LESSON 19

		o
ho	h	ho
so	j	jo
Jo	g	go
go	s	so
(do)	n	no

LEVEL V, LESSON 23

		ose	ome
nose	h	hose	home
hose	r	rose	rome
home	n	nose	
rose	p	pose	
Rome			
pose			
(lose)			
(some)			
(come)			

LEVEL V, LESSON 27

		isk	imp
chimp	wh	whisk	ch
whisk	r	risk	bl
frisk	fr	frisk	l
blimp			
limp			
risk			
(imp)			
(twist)			

LEVEL V, LESSON 20

(Review)

LEVEL V, LESSON 24

		ode
lode	l	lode
code	c	code
rode	r	rode
mode	m	mode

LEVEL V, LESSON 28

(Review)

APPENDIX A (continued)

LEVEL V, LESSON 29

		ink	ilt
wilt	l	link	lilt
slink	w	wink	wilt
silt	s	sink	silt
brink	br	brink	
wink	sl	slink	
link			
lilt			
sink			
(wind)			

LEVEL V, LESSON 30.1

		ent	est
rest	t	tent	test
best	b	bent	best
rent	r	rent	rest
tent	s	sent	
test			
bent			
sent			

LEVEL V, LESSON 30.2

		est
west	w	west
pest	j	jest
vest	v	vest
jest	p	pest
(hemp)		
(fern)		

LEVEL V, LESSON 30.3

		elt	eld
welt	f	felt	
pelt	b	belt	
held	h	held	held
felt	w	welt	weld
melt	m	melt	meld
weld	p	pelt	
belt			

LEVEL V, LESSON 30.4

		end	eth	elf
self	s	send	seth	self
rend	t	tend	teth	
Beth	r	rend	reth	
tend	m	mend	meth	
mend	b	ben ~~d~~	beth	
send				
bend				
Seth				
(end)				

LEVEL V, LESSON 30.5

		ent	end	esk
lend	d	dent	dend	desk
dent	l	lent	lend	
vent	w	went		
desk	v	vent		
lent				
went				

LEVEL V, LESSON 30.6

		ent	end	est
Trent	bl	blent	blend	blest
spent	sp	spent	spend	
blest	tr	trent	trend	trest
trend				
blend				
spent				

LEVEL V, LESSON 31

		ute	ube
June	t		tube
dune	c	cute	cube
tune			
cube			
cute	j	june	
tube	t	tune	
(huge)	d	dune	
(fuse)			
(lute)			
(use)			

LEVEL V, LESSON 32

		ench	esh
bench	fr	french	fresh
fresh	tr	trench	
clench	dr	drench	
trench	cl	clench	
drench	st	stench	
French	b	bench	
stench			

LEVEL V, LESSON 33

		ank	ink
prank	pl	plank	plink
blink	dr	drank	drink
drank	bl	blank	blink
spank	sp	spank	
plink	pr	prank	
blank			
drink			
plank			

LEVEL V, LESSON 34

		ink	ank
clank	th	think	thank
thank	cl	clink	clank
stink	st	stink	stank
clink			
stank			
think			

LEVEL V, LESSON 35

(Review)

APPENDIX A (continued)

LEVEL V', LESSON 1

ee	
b	bee
f	fee
l	lee
s	see
w	wee

LEVEL V', LESSON 5

eep		eer	
j	jeep		jeer
l			leer
sn			sneer
b	beep		

LEVEL V', LESSON 9

eek		eet		eef	
m	meek		meet		meef
b			beet		beef
l	leek				
r	reek				reef
gr	greek				

LEVEL V', LESSON 13

ear		eap	
h	hear		heap
r	rear		reap
d	dear		
f	fear		
n	near		

LEVEL V', LESSON 2

ee	
spr	spree
thr	three
fl	flee
gl	glee
fr	free
tr	tree

LEVEL V', LESSON 6

eer		een	
qu	queer		queen
d	deer		
s			seen
st	steer		
ch	cheer		
sh	sheer		

LEVEL V', LESSON 10

eed		eet	
gr	greed		greet
tw	tweed		tweet
bl	bleed		
sp	speed		
br	breed		
fr	freed		

LEVEL V', LESSON 14

eal		eat	
h	heal		heat
m	meal		meat
s	seal		seat
p	peal		peat

LEVEL V', LESSON 3

eep		eek	
p	peep		peek
s	seep		seek
w	weep		week
d	deep		
k	keep		

LEVEL V', LESSON 7

eet		een	
sh	sheet		sheen
sw	sweet		
gr			green
str	street		
scr			screen
fl	fleet		

LEVEL V', LESSON 11

eed		eel	
st	steed		steel
cr	creed		creel
wh			wheel
w	weed		
s	seed		
d	deed		

LEVEL V', LESSON 15

ead		eat	
b	bead		beat
f			feat
l	lead		
r	read		
pl	plead		pleat
n			neat

LEVEL V', LESSON 4

eep		eek	
cr	creep		creek
sl	sleep		sleek
ch	cheep		cheek
sh	sheep		
sw	sweep		
st	steep		

LEVEL V', LESSON 8

eed		eel		eet	
f	feed		feel		feet
r	reed		reel		
h	heed		heel		
n	need				

LEVEL V', LESSON 12

ea	
l	lea
p	pea
s	sea
t	tea
fl	flea
pl	plea

LEVEL V', LESSON 16

eal	
d	deal
r	real
v	veal
b	beal
st	steal

APPENDIX A (continued)

LEVEL V', LESSON 17

eam	
r	ream
s	seam
t	team
str	stream
scr	scream

LEVEL V', LESSON 20

ean	
cl	clean
w	wean
m	mean
d	dean
j	jean

LEVEL V', LESSON 24.1

oy oin	
c	coy coin
j	joy join
r	roy
l	loin
tr	troy
	(floyd)
	(boyd)

LEVEL V', LESSON 27

ing ang ung		
cl	cling	clang clung
sl	sling	slang slung
fl	fling	flung

LEVEL V', LESSON 18

eam ean	
b	beam bean
gl	gleam glean
cr	cream
st	steam
dr	dream

LEVEL V', LESSON 21

ead eaf	
d	dead deaf
h	head
l	lead
r	read
spr	spread
tr	tread

LEVEL V', LESSON 24.2

ind ild	
m	mind mild
w	wind wild
ch	child
gr	grind

LEVEL V', LESSON 28

ing ang ong ung			
s	sing	sang	song sung
r	ring	rang	rung
k	king		
w	wing		

LEVEL V', LESSON 19.1

eak eat	
bl	bleak bleat
wh	wheat
sn	sneak
tr	treat
fr	freak
ch	cheat

LEVEL V', LESSON 22

ear eak	
b	bear beak
p	pear peak
t	tear teak
w	wear weak

LEVEL V', LESSON 25

oil oy	
b	boil boy
c	coil
s	soil soy
t	toil toy
br	broil
sp	spoil

LEVEL V', LESSON 29

ing ong ung		
str	string	strong strung
th	thing	thong
pr		prong
thr		throng
br	bring	

LEVEL V', LESSON 19.2

eak ear	
sp	speak spear
cl	clear
l	leak
cr	creak
sm	smear
str	streak
	(break)

LEVEL V', LESSON 23

ind	
b	bind
f	find
h	hind
k	kind
r	rind
bl	blind
	(pint)

LEVEL V', LESSON 26

ing ong ang		
b	bing	bong bang
p	ping	pong pang
d	ding	dong
t	ting	tong
j	jing	
l	ling	

LEVEL V', LESSON 30

ing ung ang		
spr	spring	sprung sprang
sw	swing	swung
st	sting	stung

APPENDIX A (continued)

LEVEL V', LESSON 31

	ang	ung	ong
h	hang	hung	
l		lung	long
g	gang		gong

LEVEL V', LESSON 35

	oat	oal
c	coat	coal
g	goat	goal
b	boat	
f		foal
m	moat	
fl	float	
thr	throat	

LEVEL V', LESSON 39

	oak	oar
s	soak	soar
cl	cloak	
r		roar
cr	croak	
b		boar

LEVEL V', LESSON 43

	ort	orl
sn	snort	snorl
sh	short	shorl
sc		scorl
sp	sport	
p	port	
w	wort	

LEVEL V', LESSON 32

	oo
b	boo
c	coo
m	moo
t	too
w	woo
z	zoo

LEVEL V', LESSON 36

	oad	oam	oaf
l	load	loam	loaf
r	road	roam	
t	toad		
f		foam	
g	goad		

(broad)

LEVEL V', LESSON 40

	oke	ore
p	poke	pore
w	woke	wore
y	yoke	yore
c	coke	core
j	joke	

LEVEL V', LESSON 44

	orn	ord
c	corn	cord
f		ford
b	born	
h	horn	
t	torn	
w	worn	

(sword)

LEVEL V', LESSON 33

	old
g	gold
h	hold
f	fold
s	sold
t	told
sc	scold

LEVEL V', LESSON 37

	ole	ost
p	pole	post
m	mole	most
h	hole	host
r	role	
s	sole	

(cost)
(lost)

LEVEL V', LESSON 41

	oke	ore
ch	choke	chore
sp	spoke	spore
st	stoke	store
sm	smoke	
br	broke	
str	stroke	

LEVEL V', LESSON 45

	ow	oan
l	low	loan
r	row	roan
m	mow	moan
b	bow	
s	sow	
t	tow	

LEVEL V', LESSON 34

	olt	old
b	bolt	bold
m	molt	mold
c	colt	cold
j	jolt	

LEVEL V', LESSON 38

	ove
c	cove
d	dove
r	rove
cl	clove
dr	drove
st	stove

(grove)
(stove)
(jove)

LEVEL V', LESSON 42

	ore	ort
m	more	mort
f	fore	fort
s	sore	sort
t	tore	tort

LEVEL V', LESSON 46

	ow	own
sh	show	shown
bl	blow	blown
sl	slow	
thr	throw	thrown
s	sow	sown

APPENDIX A (continued)

LEVEL V' LESSON 47

	ow	own
gr	grow	grown
fl	flow	flown
sn	snow	
gl	glow	
cr	crow	
m	mow	mown

LEVEL V' LESSON 51

	ow	own
br	brow	brown
pr	prow	
dr		drown
fr		frown
cr		crown
ch	chow	

LEVEL V' LESSON 55

	awn	awl
br	brawn	brawl
dr	drawn	drawl
c		cawl
l	lawn	
d	dawn	
f	fawn	

LEVEL V' LESSON 59

	ew	aw
fl	flew	flaw
dr	drew	draw
bl	blew	
gr	grew	
ch	chew	
st	stew	

LEVEL V' LESSON 48

	ow	out
b	bow	bout
p	pow	pout
h	how	
n	now	
c	cow	
s	sow	

LEVEL V' LESSON 52

	ow	out
sc	scow	scout
pl	plow	
st		stout
br	brow	
sn		snout
spr		sprout

LEVEL V' LESSON 56

	ove
d	dove
l	love
gl	glove
sh	shove (move)

LEVEL V' LESSON 60

	aw	ew
cr	craw	crew
sl	slaw	slew
cl	claw	
str	straw	
th	thaw	

LEVEL V' LESSON 49

	out	oud
l	lout	loud
cl	clout	cloud
tr	trout	
pr		proud
sh	shout	
sp	spout	

LEVEL V' LESSON 53

	alk
b	balk
c	calk
t	talk
w	walk
st	stalk
ch	chalk

LEVEL V' LESSON 57

	ue	uke
d	due	duke
fl	flue	fluke
s	sue	
bl	blue	
tr	true	(luke)
gl	glue	

LEVEL V' LESSON 50

	ow	own
d		down
r	row	
t		town
w	wow	
g		gown

LEVEL V' LESSON 54

	aul
h	haul
m	maul
p	paul
s	saul

LEVEL V' LESSON 58

	ew	aw
p	pew	paw
h	hew	haw
j	jew	jaw
d	dew	
f	few	
n	new	

APPENDIX B

Contractions

LEVEL I, 4:	I'm it's who's what's
I, 11:	he's she's
III, 3:	they're
III, 4:	we're you're
III, 11:	I'll we'll
III, 16:	don't can't isn't wasn't aren't didn't
IV, 8:	there's
IV, 17	wouldn't

APPENDIX C

Function Words Presented in Levels I - V

I, 1:	a	III', 2:	be may might can could
I, 2:	an		
I, 3:	the		
I, 4:	this	III', 4	very really pretty almost
I, 11:	have is that		
II, 1:	and	III', 5:	not
II, 6:	on in at to	III', 6:	our their these those
II, 9':	of or	III', 7:	will would should must
III, 7:	as has	III', 9:	fairly too more less
III, 16:	are		
III, 23:	was were	III', 11:	this that each every
III', 1:	I he she said says my your his her	III', 12:	been too has had
		III', 14:	both few some many most

APPENDIX C

Function Words (continued)

III', 15:	was got kept	III', 23:	which when why where now
III', 17:	for with over up	III', 24	whenever because since before so
III', 18:	and both either or but	III', 26:	much any most some even
III', 20:	from by across after	IV, 22:	who what when where why
III', 21:	do does did there	IV', 7:	under down out off

APPENDIX D

Compound Words

LEVEL III

(11)batman
madman
flagman
pitman
ragman

(12)mailbag
sandbag
beanbag
ragbag
handbag

(13)bedroom
bedbug
bedtime
bedside
bedspread

(15)caveman
fireman
mailman
manhole
manhunt

(16)pinpoint
pinstripe
pinhead
hatpin
tenpin

(18) whaleship
warship
shipwreck
shipload
shipyard

(19)panfry
pancake
panfish
dustpan
dishpan

LEVEL III'

(12)catfish
catwalk
catbird
catgut
cattail

(13)handbell
bluebell
cowbell
bellpull
doorbell

(14)snowfall
snowcap
snowman
snowflake
snowball

(17)starbright
starship
starfish
polestar
starlight

(18) sandhill
downhill
molehill
hilltop
hillside

(22)sawtooth
handsaw
sawdust
sawmill
sawfish

(23)sunglass
spyglass
glassware
glassfish
hourglass

(26)nutshell
shellfish
clamshell
eggshell
seashell

LEVEL IV

(13)birdbath
footbath
bathroom
bathtub
bathrobe

(15)sandstone
sandbox
quicksand
sandbar
sandstorm

APPENDIX D (continued)

Compound Words

LEVEL IV

(16) washday
washboard
washtub
washcloth
whitewash

(18) clothesline
hairline
fishline
skyline
headline

(21.1) nighttime
mealtime
springtime
wartime
lifetime

(17) woodland
grassland
elfland
landlord
landslide

(20) seaside
roadside
sidewalk
sideline
sidcar

(21.2) horsefly
firefly
housefly
flyspeck
flytrap

APPENDIX E

Polysyllabic Words

LEVEL III'

(1)*letter
*better
setter

(2) batter
*matter
patter
chatter
spatter
platter

(3)*dinner
winner
spinner
thinner

(4) bagger
stagger
tagger
dagger

(5) bitter
litter
flitter
glitter

(6)*ladder
bladder
hammer
stammer
flipper
*slipper

(8) tender
slender
fender
blender
mender

(9) camper
pamper
tamper
damper
hamper

(10.1) winter
printer
banter
canter

(11) chipping
clipping
snipping
dripping
flipping

(12) hitting
fitting
flitting
slitting

(13) bedding
wedding
netting
setting

(14) whimper
simper
shimmer
glimmer

(16)*middle
*riddle
fiddle
griddle

(17)*cattle
battle
rattle
tattle

(18)*saddle
*paddle
daddle
faddle

(19)*little
whittle
ripple
cripple
brittle

(20) dabble
babble
dribble
nibble

(22) candle
handle
spindle
swindle

(23) dimple
simple
trample
sample

(24) nimble
*thimble
ramble
bramble

(25) bitty
ditty
witty
gritty

(26) Fanny
Danny
nanny
granny

(27)*happy
snappy
snippy
nippy

LEVEL IV

(1) silly
filly
dilly
hilly
chilly

(2) cabby
Tabby
crabby
shabby

(3) carry
marry
tarry
Larry
Harry
Barry

(4)*penny
Henny
whinny
shinny

(5) dandy
sandy
candy
handy
daddy
paddy

(7) gladly
sadly
manly
Stanly

(8) sadden
gladden
fatten
flatten

(9) hidden
ridden
mitten
bitten

(11) starling
darling
sparling

(12) scarlet
starlet
piglet
wiglet

(13) Ricky
Micky
Nicky
tricky
sticky

(15) sticker
slicker
flicker
thicker

(16) cracker
slacker
wicker
dicker

(17) pickle
tickle
prickle
trickle

(18) crackle
cackle
tackle
freckle
speckle

(20) ticket
wicket
cricket
thicket
packet
racket

(21.1) market
carpet
target

(21.2) harbor
barber
garden
pardon

APPENDIX E (continued)

LEVEL IV'

(1) poppy choppy floppy sloppy	(11) mister sister blister whisper crisper	(21) ribbon gibbon cotton common	(29.2) cannery tannery battery flattery
(2) Bobby hobby lobby snobby	(12) baggage cabbage cottage passage	(22) wispy crispy risky frisky	(30) pottery tottery coppery
(3) bonny Ronny mommy Tommy	(13) bandage bondage garbage hostage	(24) medal pedal metal petal	(31) sticky flickey crickety rickety
(4) merry ferry berry cherry Terry	(14) cobble wobble gobble hobble	(25.1) tropic topic tonic comic	
(5) chicken thicken blacken slacken	(15) toddle coddle mottle bottle	(25.2) mimic clinic limit spirit	
(6) tatter flatter clatter shatter	(17) cobbler wobbler gobbler hobbler	(26) wagon dragon satin Latin	
(8) moppet poppet sonnet bonnet	(18) babbler dabbler dribbler nibbler	(27) hammering stammering shimmering glimmering	
(9) tablet crabnet chiplet triplet	(19) copper shopper popper	(28) fluttering glittering littering	
(10) master plaster faster raster	(20) hotter potter blotter totter	(29.1) pampering tampering cantering bantering	

APPENDIX F

Adverbials

IV-1
quickly
often
usually

IV-2
slowly
soon
sometimes

IV-3
instead
carefully
again

IV-4
next
gently
carelessly

IV-5
quietly
secretly
silently

IV-7
yesterday
then
first

IV-8
noisily
softly
loudly

IV-9
now
still
already

IV-11
angrily
once
later

IV-12
easily
tonight
lately

IV-13
here
there
today

IV-15
always
daily
generally

IV-16
outside
twice
away

IV-17
every day
every morning
every night

IV-18
each day
each morning
each night

IV-20
upstairs
downstairs
inside

IV-21.1
last night
last week
last year

IV-21.2
a lot
nicely
badly

IV-22
this morning
this afternoon
this evening

APPENDIX G

LEVEL I - Games

Lesson 1	"Find The Rule"
2	"Find The Rule"
3	"Find The Rule"
4	No game
5	"Find The Rule"
6	"Find The Rule"
7	"Find The Rule"
8	Bingo
9	"Find The Rule"
10	"Find The Rule"
11	Baseball
12	"Find The Rule"
13	"Find The Rule"

LEVEL II

Lesson 1	No game
2	Vowel Contrast
3	"Find The Rule"
4	No game
5	Vowel Contrast
6	"Find The Rule"
7	No game
8	No game
9.1	Riddle Game
9.2	"Find The Rule"
10	Vowel Contrast
11	Vowel Contrast
12	No game
13	"Find The Rule"
14	Rhyme Game
15	Rhyme Game
16	"Find The Rule"
17	No game
18	No game

LEVEL III

Lesson 1	Bingo
2	Draw a Boy
3	"Find The Rule"
4	Vowel Contrast
5	Hopscotch
6	The Monkey's Playmates
7	"Find The Rule"
8	Baseball
9	Riddle Game
10	Vowel Contrast
11	Draw a Boy
12	"Find The Rule"
13	Riddle Game
14	"Find The Rule"
15	Baseball
16	The Monkey's Playmates
17	"Find The Rule"
18	Bingo
19	Vowel Contrast
20	Darts
21	Hopscotch
22	"Find The Rule"
23	Baseball

LEVEL III'

Lesson 1	Bingo
2	"Find The Rule"
3	Draw a Boy
4	Vowel Contrast
5	How many stars can you get?
6	"Find The Rule"
7	Darts
8	Baseball
9	Bingo
10	"Find The Rule"
11	Vowel Contrast
12	Bingo
13	Darts
14	"Find The Rule"
15	Riddle Game
16	Vowel Contrast
17	How many stars can you get?

APPENDIX G (continued)

LEVEL III' (cont.)

Lesson 18	Darts
19	"Find The Rule"
20	Baseball
21	Darts
22	Hopscotch
23	Bingo
24	"Find The Rule"
25	Vowel Contrast
26	Bingo
27	Baseball
28	"Find The Rule"

LEVEL IV

Lesson 1	"Find The Rule"
2	Go-cart Race
3	Vowel Contrast
4	Hopscotch
5	"Find The Rule"
6	How many stars can you get?
7	Vowel Contrast
8	Baseball
9	"Find The Rule"
10	Bingo
11	Vowel Contrast
12	Draw a Boy
13	"Find The Rule"
14	Riddle Game
15	Vowel Contrast
16	Baseball
17	"Find The Rule"
18	Go-cart Race
19	Vowel Contrast
20	Bingo
21.1	"Find The Rule"
21.2	The Monkey's Playmates
22	Vowel Contrast

LEVEL IV'

Lesson 1	Go-cart Race
2	Riddle Game
3	"Find The Rule"
4	Vowel Contrast
5	Baseball
6	Draw a Boy
7	"Find The Rule"
8	Bingo
9	Vowel Contrast
10	Darts
11	How many stars can you get?
12	Vowel Contrast
13	Hopscotch
14	The Monkey's Playmates
15	"Find The Rule"
16	Vowel Contrast
17	Bingo
18	"Find The Rule"
19	Baseball
20	Vowel Contrast
21	Darts
22	Go-cart Race
23	"Find The Rule"
24	How many stars can you get?
25	Baseball
26	Vowel Contrast
27	"Find The Rule"
28	Draw a Boy
29	Bingo
30	Vowel Contrast
31	Darts
32	"Find The Rule"

APPENDIX H

Stories Read to the Children

LEVEL I

Lesson 1	The Camel and the Pig	5	Choice of one from
2	The Funny Airplane		above four
3	(Review)	6	Robert Louis Stevenson
4	Three Billy Goats Gruff		Poetry
5	Three Little Kittens	7	The Golden Touch
6	Bremontown Musicians	8	Using Words
7	(Review)	11	The Snow Maiden
8	(Review)	12	Choice of one from
9	The Princess and the Pea		above four
10	Games in the Sky	13	Feathers of the
11	Collection of Nursery		Mountain
	Rhymes	14	Robert Louis Stevenson
12	The Milkmaid and Her Pail		Poetry
13	Little Red Riding Hood	15	The Shoemaker and the
14	(Review)		Elves

LEVEL II

Lesson 1	Tom Thumb (Part I)
2	The Magic Paintbox
3	Jack and the Beanstalk
4	Collection of Nursery
	Rhymes
5	The Hare and the Tortoise
6	Rumpelstiltskin
7	Story Words
8	The Coyote and the Blue-
	bird
9	The Death of a Leaf
9'	Words for Fun
10	The Old Woman in the
	Vinegar Bottle
11	The Battle of the Fire-
	Flies and the Apes
12	Old Mother Hubbard
13	How We Got the Heavens
14	The Gingerbread Man
15	The Owl and the Pussy
	Cat
16	The Ugly Duckling
17 & 18	(Review)

LEVEL III'

Lesson 1	Three Little Pigs
2	The Turtle Who Could
	Not Stop Talking
3	Dinosaurs
4	The Lobster's Quadrille
5	Choice of one from
	above four
*6	The Whale Who Does
	Tricks
7	(Review)
8	The Cock, The Mouse,
	and the Little Red Hen
9	The Wonderful Weaver
10	The Dragon In The
	Yard
11	Choice of one from
	above four
12	The Pied Piper
13	Modifying Words
14	The Emperor's New
	Clothes
15	Review
16	Quangle Wangle's Hat
17	Choice of one from
	above four

LEVEL III

Lesson 1	Puss In Boots
2	The Brave Mother
	Elephant
3	Sugaring Off
4	The Country Mouse and
	the City Mouse

APPENDIX H (continued)

LEVEL III' (cont.)

Lesson 18	The Crooked Tree
19	Tom Brown's Crock
20	The Stolen Charm
21	(Review)
22	The Wind and the Sun
23	Choice of one from above four
24	A Dog Goes To School
25	I'll Do Something For You
26	The Painter of Cats
27	Choice of one from above four
28	(Review)

LEVEL IV

Lesson 1	The Princess and Her Golden Ball
2	The Boy Who Cried Wolf
3	Father William
4	A Bad Start
5	Choice from above four
6	(Review)
7	Fireman's Mascot
8	The Two Brothers
9	Admetus and the Beggar
10	(Review)
11	The Luck of Puck
12	Choice from the above four
13	How We Got Linen and Cotton Cloth
14	(Review)
15	The Woodcutter's Sake
16	The Legend of The Water Lily
17	The Jumblies
18	Choice from above four
19-22	(Review)

LEVEL IV'

Lesson 1	The Tale of Peter Rabbit
2	Fire Guard
3	Words
4	The Boy Who Wanted the Impossible
5	Choice of one from above four
6	The Gift of The Corn
7	(Review)
8	Nonsense Verse
9	Here Come The Clowns
10	Teeny-Tiny
11	Choice of one from above four
12	Tailspin Eddie
13	The Fox
14	How The Finch Got Her Colors
15	The 12 Dancing Princesses
16	(Review)
17	Choice of one from above four
18	The Birthday Purse
19	Words
20	The Wise Leprechaun
21	Get A Horse!
22	Choice of one from above four
23	(Review)
24	Nursery Rhyme on Months
25	The Little Rabbit Who Wanted Red Wings
26	Gorillas At Play
27	Choice of one from above four
28	The Two Crabs
29	Eyes For A Blind Person
30	The Ship And The Ash Lad
31	Choice of one from above four

APPENDIX I

Stories the Children Read

LEVEL III'

Lesson 1 What Did They Get?

- 2 A Mad Hat
- 3 The Ram in the Bin
- 4 Tab and Wag
- 5 Pig in a Pit
- 6 Wag and the Tin Lid
- 7 The Shipwreck
- 8 The Male Caper
- 9 Dave and the Cakeman
- 10 Red and the Hen
- 10.2 What's In the Bag?
- 11 Pam Wins It
- 12 Tapper Taps the Can
- 13 The Winner
- 14 The Chick Takes a Trip
- 15 The Snowman
- 16 Nate and the Mate
- 17 Chipper the Fir
- 18 The Big Dinner
- 19 The Pack Trip
- 20 Tad the Crab
- 21 Polestar
- 22 Flipper's Trade
- 23 Fall and Winter

24 Trip on a Ship

- 25 The Class Takes a Trip
- 26 Chip, the Chick
- 27 Swimming
- 28 The Animal Ball

LEVEL IV

- 1 Tim and Chan
- 2 Flipper the Whale
- 3 Crabby Tabby
- 4 Little Snowflake
- 5 Stan and the Stag
- 6 Lot's Trick
- 7 A Riddle for a Sled
- 8 The Shipyard
- 9 The Snapping Crab
- 10 Sir Gladden
- 11 Dick and Rin Tin Tin
- 12 The Capering Cats
- 13 Tripper the Dane
- 16 Rag Tag and Mop Top
- 18 The Bell That Was Still
- 19 The Antmen
- 21.1 Sid and Madcap
- 22 Can You Tell?

References

- Atkinson, R. C., G. H. Bower, and E. J. Crothers. An introduction to mathematical learning theory. New York: John Wiley and Sons, Inc., 1965.
- Bloomfield, L. Linguistics and reading. Elementary English Review, 1942, 19, 125-130.
- Bloomfield, L. and C. L. Barnhart. Let's Read: A Linguistic Approach. Detroit: Wayne State University Press, 1961.
- Brown, R. and C. Fraser. Acquisition of syntax. In C. N. Cofer and B. Musgrave (Eds.), Verbal Behavior and Learning. New York: McGraw Hill, 1963.
- Carroll, J. The analysis of reading instruction: perspectives from psychology and linguistics. In E. Hilgard (Ed.), Theories of Learning and Instruction, N.S.S.E. 63rd Yearbook. Chicago: University of Chicago Press, 1964, 336-353.
- Carterette, E. C. and M. H. Jones. Phoneme and letter patterns in children's language. In Proceedings of Symposium on the Psycholinguistic Nature of the Reading Process. Wayne State University: in press, 1965.
- Chall, J. S. Readability: An Appraisal of Research and Application. Columbus, Ohio: Bureau of Educational Research, 1958.
- Chomsky, N. Aspects of the Theory of Syntax. Cambridge, Massachusetts: M.I.T. Press, 1965.
- David, D. The Festival of Dolls. In D. H. Parker and G. Scannell (Eds.), Reading Laboratory Ia. Chicago: Science Research Associates, Inc., 1961.
- Fries, C. Linguistic and Reading. New York: Holt, 1963.
- Gibson, E. G., J. J. Gibson, Anne D. Pick, and H. Osler. Developmental study of the discrimination of letter-like forms, Journal of Comparative Physiological Psychology, 1962, 55, 892-906.
- Halle, M. and K. N. Stevens. A Model and A Program for Research, IRE Transactions of Information Theory, IT-8, 1962, 155-9.
- Hansen, D. N. Application of computers to research on instruction. A paper read at the National Society of College Teachers of Education. Symposium Title: "Applications of Computer-Assisted Instruction at the College and University Level," February 17, 1966.

- Hansen, D. N. Reduplication of Word sequences as a factor in Initial Reading. In preparation.
- Hansen, D. N. and T. S. Rodgers. An exploration of psycholinguistic units in initial reading. Technical Report 74. Institute for Mathematical Studies in the Social Sciences, Stanford University, 1965.
- Lefevre, C. Linguistics and the Teaching of Reading. New York: McGraw-Hill, 1964.
- Mackinnon, A. R. How Do Children Learn to Read? Vancouver: Copp Clark Publishing Co., Ltd., 1957.
- Pike, K. L. The Intonation of American English. Ann Arbor: University of Michigan Press, 1945.
- Postal, P. M. Underlying and superficial linguistic structure. Harvard Educational Review, 1964, 34, 246-266.
- Smith, H. P. and E. V. Dechant. Psychology in Teaching Reading. Englewood Cliffs, New Jersey: Prentice-Hall, 1961.
- Thorndike, E. L. and C. L. Barnhart (Eds.), Thorndike Barnhart Beginning Dictionary. New York: Scott, Foresman, and Co., 1964.
- Thorndike, E. L. and I. Lorge. The Teacher's Word Book of 30,000 Words. New York: Columbia University Press, 1944.
- Wright, W. W. The Rainbow Dictionary. Cleveland: World Publishers Company, 1959.